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Adult Education

Toward Ubiquitous Learning for Adults: Opportunities Enabled by Artificial Intelligence

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Abstract

Adult learning and continuous upskilling throughout the life course are essential conditions for active citizenship and workforce adaptability. Within the European Education strategic framework, a target has been set for at least 60% of adults aged 25–64 to have participated in learning activities during the previous 12 months by 2030. However, according to the European Commission's Education and Training Monitor 2025, adult participation in learning stood at only 39.5% in 2022. Against this backdrop, this paper explores how digital technologies in general and artificial intelligence in particular, may prefigure a ubiquitous and engaging learning experience for adult learners, provided that effective strategies for orientation and personalization are implemented and that a multidimensional interpretative pedagogical paradigm is adopted.

Keywords: *personalization, IA, ubiquitous learning, complex learning, adult learning*

Introduction

The European Pillar of Social Rights Action Plan increased its ambition by setting a target of 60% of adults aged 25–64 participating in learning within the previous 12 months by 2030, up from 47%. However, the *Education and Training Monitor 2025* [14] reports that participation reached only 39.5% in 2022. Similarly, the *Survey of Adult Skills (PIAAC) 2023* [40] shows an average rate of 40.8% across 20 EU Member States, broadly consistent with 2022.
The OECD report *Trends in Adult Learning 2025* [39] identifies key barriers to participation. The main obstacle is lack of time due to work and family responsibilities (48%), followed by limited suitable training (14%) and financial costs (13%). These constraints reduce motivation and willingness to engage. Negative experiences in formal education also discourage many adults.
A recent literature review [44], based on data from 2000–2025 across multiple Countries, groups barriers into three categories: situational, institutional and personal. Situational barriers include work–study conflicts, life–work balance issues, time limits, and financial constraints. Institutional barriers involve organisational inflexibility, limited interaction or social isolation, and technological or access difficulties. Personal barriers mainly concern low self-confidence and fear of failure.
Additionally, adults often experience confusion when navigating training opportunities. Many have established careers and routines shaped by specific life trajectories, habits and learning strategies, which can limit access to standardised or rigid pathways.
Against this backdrop, this paper explores how digital technologies, particularly artificial intelligence, can support more ubiquitous, flexible and engaging learning for adults. This potential depends on effective orientation and personalisation strategies, as well as a multidimensional pedagogical paradigm capable of addressing the complexity of adult learning trajectories.

1. Adult Learning Personalization Requirements

To increase adult participation in formal and non-formal learning, a shift in prevailing educational paradigms is needed. One response is adopting a framework that promotes ubiquitous, flexible, and engaging learning experiences. Such a framework should rely on personalization strategies and a multidimensional pedagogical approach capable of addressing the complexity of adult learning trajectories. This perspective can better align provision with learners' needs while supporting target achievement.
Personalizing learning is challenging, as it requires adapting pathways to learners' characteristics, needs, and dispositions. Drawing on the andragogic framework [28], this implies a learner-centred approach based on adult learners' key traits:

- need to understand why they must learn something;
- see themselves as self-directed and responsible for their choices;
- use prior experience as a resource;
- become ready to learn when facing real-life demands;
- face task-oriented and problem-centred assignments;
- are are primarily motivated by internal factors such as self-esteem, professional fulfilment and quality of life.

Accordingly, learning environments should help adults recognize and valorize prior experiences and actively co-design their pathways. Practical relevance and applicability should guide training, connecting it to everyday contexts, integrating informal learning and reducing disengagement [41].
Despite its complexity, a personalized approach produces positive outcomes, especially for learners with interrupted or negative educational experiences, enhancing accessibility and inclusion. However, it is time-consuming, requiring data collection, assessments and skilled trainers able to design learner profiles and tailored pathways, an even greater challenge in group settings.
Today, AI-driven solutions significantly ease this process [46] [63]. AI tutoring applications combine flexibility, adaptability and learner agency through dialogic interaction, aligning with personalized learning principles. Algorithms enable customization based on individual needs, preferences, and pace [1] [34]. Unlike general chatbots, AI tutoring systems dynamically generate and adapt study plans, functioning as learning contracts within a dialogic framework [45]. They adjust task difficulty to learner performance, guiding practice through reinforcement while identifying errors formatively [3].
Rather than replacing human guidance, AI-based personalization amplifies the Zone of Proximal Development theorized by Vygotsky [61], traditionally supported by tutors or peers. Unlike human instructors, it operates without fatigue. These solutions, often freely available, range from simple tools to advanced systems, making learning more inclusive, accessible and effective while enabling learners to fully develop their potential.

2. Learning in the Ecosystem

The extraordinary potential of AI-based technologies in enhancing personalized learning nonetheless faces a structural limitation: it remains confined within the interactional boundaries of the device through which it operates. AI-driven learning applications often become self-contained systems, reproducing, albeit in new forms, the traditional boundaries of the classroom. This limits their ability to support truly lifelong learning grounded in adult needs, fostering self-direction, integrating informal and non-formal dimensions, and aligning with learners' biographies and daily lives. Even with advanced AI, the "rear-view mirror syndrome" described by McLuhan [36] reappears, without breaking the "fourth wall" theorized by Pirandello: a necessary condition for making learning genuinely interactive. This requires overcoming fixed roles and structures, to reflect the fluid nature of adult learning.
The concept of a learning ecosystem, as framed by Bronfenbrenner [10], is crucial to reach this aim: technology is only one component of a broader system shaped by interactions among institutions, contexts (formal, non-formal, informal) and the relationships between subjects, objects, times, and places of learning [30]. Within this system, AI tutoring applications act as active agents alongside human participants.
Transforming learning into a personalized, adaptive lifelong process within a ubiquitous ecosystem requires rethinking these categories and their relationships. The goal is to map and connect learning environments, physical and virtual, to design personalized pathways. Urban spaces frequented by adults become not just contexts but "learning activation devices," serving as nodes in continuous educational networks.
One could envision a distributed network of "learning dashboards," connecting diverse environments such as fast-food venues, shopping centres, archaeological sites, natural areas, libraries, schools, businesses, travel agencies, sports centres or bookstores. While once utopian, early initiatives like the ARIADNE project [15] in the 1990s explored interoperable platforms for adaptive learning, laying the groundwork for flexible, modular environments during the growth of the web.
Today, AI strengthens these connections, enabling not only interconnected resources, but integrated ecosystems and personalized pathways. Interoperability expands beyond technology to include experiential and contextual dimensions, forming dynamic systems that adapt to individual needs.
The sense of disruption that this vision can create reflects the scale of the paradigm shift driven by AI. Overcoming the "rear-view mirror syndrome" means moving from accumulation-based models to those based on distribution and flow. In this sense, Serres, in *C'était mieux avant!* [49], captures this transformation: what was once concentrated is now diffused and circulating.

Within this framework, learning may begin in informal or non-formal contexts and later be formalized within institutions, creating a virtuous circular relationship among diverse learning environments.

2.1 Breaking the "Fourth Wall": A Possible Application

Widespread museum initiatives embody the concept of a ubiquitous learning ecosystem, connecting diverse cultural environments, physical and virtual, and fostering synergies among formal, non-formal, and informal actors in urban and rural contexts, integrating learning into spaces frequented by adults [16] [32].
Consider a daily commute. In a city like Rome, even a short journey reveals rich historical stratification: passing the Pyramid of Cestius, skirting Porta San Paolo, once part of the city walls (275 AD) and later a site of resistance, and walking alongside the Non-Catholic Cemetery, resting place of poets and intellectuals. One might also encounter an early "Casa dei Bambini" founded by Maria Montessori. This brief route encapsulates multiple eras, showing how urban space can act as a pervasive cultural environment and learning device. Similar dynamics exist also in rural contexts, offering rich links between space, memory and education.
The widespread museum provides diverse stimuli within an ecosystem enabling informal and non-formal learning across cultural, naturalistic and recreational domains. However, the relevance of each stimulus depends on the learner's biography, experiences and dispositions. For this reason, connections among environments and stimuli should extend across broader urban spaces.
Learning pathways may activate in everyday contexts such as supermarkets, theatres, libraries, bookstores and fast-food venues, as well as sport and leisure spaces. These familiar environments offer opportunities to leverage informal learning. Digital displays at bus stops or kiosks and interactive interfaces could embed access to a learning tour.
These spaces can be interconnected nodes in a hybrid, dynamic, reconfigurable network. Ecosystems inspired by the diffused museum paradigm, enhanced by digital technologies, then reflect real-world complexity. Learners play an active role in perception, interpretation, and knowledge construction, processes that unfold through cyclical and interconnected dynamics rather than linear sequences.
Such environments align with andragogic principles: experiential, meaningful, interest-driven, self-directed and oriented toward mastery [11]. However, learning in natural contexts emerges from dynamic, sometimes serendipitous interactions between learner and environment [47] and is not fully predictable. This requires moving beyond linear models; accept the unexpected, toward deeper engagement and meaning, enabling flexible, personalized trajectories.
AI-based learning systems make these transformations increasingly feasible. They support adaptive, dialogical experiences calibrated to learners' knowledge and pace, extending learning beyond classrooms and reinforcing the concept of the Personal Learning Environment [51] [62].
At the same time, such ecosystems are more complex than traditional classrooms, increasing cognitive load and requiring strong metacognitive skills. Moreover, effective learning does not arise spontaneously: a solid pedagogical framework and structured plans oriented toward clear outcomes are necessary to ground educational stimuli.
Given this complexity, learning plans should span progressively structured levels, from individual experiences to pathways and full curricula, addressing diverse needs. While AI enables personalization at the micro-level, it remains insufficient to address the systemic and contextual dimensions of adult learning, which require an ecosystemic approach and human mediation. Within this framework, the role of the Learning Personalization Trainer remains essential, alongside a coherent pedagogical paradigm.

3. The Human Agency. The Learning Personalization Trainer in the AI Age

Anyone who has used an AI-based learning tutor is likely to trust this powerful ally: a system that does not tire, judge or lose patience with mistakes.
However, for personalization and guidance to be truly effective, a human agent, a Learning Personalization Trainer (LPT), with a clear pedagogical vision remains essential [52]. This agent selects appropriate solutions, designs meaningful pathways, avoids generic responses, and identifies strategies suited to diverse needs, while also experimenting with new approaches and contributing to educational innovation.
Personalization indeed, even when AI-mediated, remains a means for individual development and identity construction. It enables learners to shape their trajectories, becoming co-authors of their growth while developing metacognitive skills for autonomous learning [27] [48]. These learning trajectories, in ubiquitous learning environments, emerges through continuous negotiation with context and others,

reshaping what adults build across formal, non-formal, and informal experiences. This process relies on complex cognitive connections, moving beyond linear models and producing highly individualized pathways. The LPT is crucial in guiding self-assessment and, the skills assessment [13] [59] [60] in reskilling contexts. Through interaction with the LPT, assessment becomes a reflective process involving professional paths, learning strategies, and emotional dimensions. The human interaction with the LPT guiding self-assessment become central to support the learner autonomy.

AI enhances these dynamics: Intelligent Tutoring Systems provide adaptive guidance, adjusting pace, offering feedback, and refining strategies. They help learners monitor progress, identify next steps, and explore solutions, gradually increasing difficulty. This reduces frustration, prevents emotional blocks, and indirectly supports trainers. At the same time, managing frustration has pedagogical value. While reducing it benefits adults, especially those with negative past experiences, it can foster resilience in adolescents. In both cases, the LPT plays a key role in balancing this dynamic.

Although AI can manage personalization, informal learning risks remaining ineffective without a meaningful framework. Here, the LPT helps position outcomes within formal structures and pathways. This framework remains provisional and evolving, with the LPT supporting interpretation, integration, and planning of future learning stages aligned with ubiquitous and personalized principles.

Another key dimension is the social nature of learning. The LPT ensures learning remains connected to broader interactions and communities. Overall, the LPT adopts a learner-centred, co-constructive approach, focusing on challenges rather than predefined goals and supporting adaptive, non-standardized pathways. The process involves collaboration in defining challenges, designing pathways, and evaluating progress, with personalization tailored to learner profiles, contexts and resources.

The LPT intervention unfolds through phases such as welcoming, interviewing, needs analysis, agreement, design, support, and evaluation. Diagnostic activities integrate interviews, self-assessment tools, and AI-supported analysis. Over time, learners take ownership of their learning, developing metacognitive and transversal skills like reflection, autonomy, collaboration, and problem solving.

The LPT can also mitigates risks related to data use, algorithmic bias, and accessibility in AI systems. Since AI may reflect human biases, human-machine interaction becomes a balancing mechanism, fostering critical awareness in learners too.

Thus, the LPT plays a pivotal role in advancing personalized adult education by integrating adaptive design, learner empowerment and continuous evaluation; promotes personalization not as a purely AI-driven adaptation, but as an intentional process aimed at strengthening adult learners' capabilities. This supports both immediate outcomes and long-term competences, while AI technologies help manage the complexity of the role in terms of data, strategies, and time.

4. A Theoretical Framework for Ubiquitous and AI Augmented Learning for Adults: Complex Learning

Understanding and governing a learning process shaped by non-linear, emergent and constantly evolving dynamics requires a multidimensional pedagogical paradigm capable of interpreting the complexity of knowledge construction. Such a paradigm must fit increasingly dynamic, holistic, serendipitous, ubiquitous and highly personalized learning pathways unfolding in open, interactive contexts marked by unpredictability and fluidity, typical of "liquid modernity" [6]. A paradigm addressing these features must integrate multiple educational dimensions. It implies the hybridization of physical and virtual learning spaces, where traditional classroom boundaries are transcended in favour of open, interconnected environments fostering multi-channel and multi-actor interaction. In this perspective, relationships among media are reconfigured according to remediation logic [9], highlighting new hierarchies among communication tools and languages.

Another element concerns the transformation of participants' roles. In complex, collaborative environments, adult learners move beyond passive reception, exercising situated and variable leadership, acting as experts de facto in their domains and actively contributing to shared knowledge construction. From this viewpoint, knowledge develops through authentic, situated experiences grounded in dialogue and collaboration [29]. Learning assumes a cyclical, recursive structure it unfolds through phases of reflection and reinterpretation that lead to new knowledge and deeper awareness [24]. Within this framework, importance is given to representative biographies [23] and competences developed across formal, non-formal, and informal contexts [54]. Learning is thus seen holistically, as a dynamic continuum rather than a sum of discrete modules. Metacognitive competences become essential, enabling learners to plan, monitor, and regulate their learning while engaging in self-assessment and continuous reorientation. Learning pathways rely on personalization, participation and

hybridization of environments, tools and communicative codes. Learners become active users and co-producers of resources within an integrated framework.
These elements converge in the Complex Learning paradigm, which interprets dialogic, networked, multi-channel learning within digital ecosystems [47] [56]. Its emergence is linked to social media, online learning communities and the growing relevance of collective knowledge systems. Through participatory and dialogic processes [5] [35], learners achieve personalized outcomes tied to their biographies and development. Learning becomes continuous reorganization and reinterpretation of knowledge across contexts, with competences progressively recognized within formal frameworks. Early conceptualizations trace back to Linda Harasim [27], who identified Complex Learning as distinct from traditional educational models. Morin's complexity paradigm [38], emphasizing interactions between order and disorder; the transactional perspective of Garrison and Anderson [18]; and connectivism [50], which views knowledge as distributed across networks of people, technologies, and information sources well display this educational frame. Later interpretations adopted in this paper [12] [20] [21] [22] [26] [58], have framed Complex Learning as an emerging pedagogical paradigm, capable of supporting genuinely learner-centred educational processes.
Consistent with ubiquitous, personalized, and learner centred approaches, Complex Learning interprets outcomes as temporary stages in an ongoing evolutionary trajectory, where new knowledge continually becomes the basis for further development. These dynamics, initially enabled by multiple media interactions, are now amplified by AI technologies.

5. Future Perspectives

From an operational standpoint, the National Lifelong Learning System represents a relevant application scenario for a distributed, adaptive AI-based learning ecosystem. In Italy, the ITS Academy system [33], a higher vocational pathway parallel to higher education, offers a suitable context. An Edutech District within ITS Academies could exemplify such an ecosystem, where educational environments act as interconnected nodes linking schools, start-ups, enterprises, and regional innovation hubs. A formal cooperation among educational stakeholders, in synergy with local industries and communities, extended into urban spaces via AI-enhanced digital displays in everyday settings, could implement this educational network.
An initial step would involve designing and validating a prototype of a dynamic, holistic, serendipitous, and ubiquitous learning ecosystem, highly personalized and applied to the ITS Academy system. An AI-augmented map could embed this model in urban environments, accessible through interactive infrastructures. Many underlying components of the complex learning ecosystem have already been tested in European projects and educational initiatives (e.g., PEAPEDA FSE/OB3/C4, EQUAL Project ComuNet IT-S2-MDL-374, LLP-LDV- TOI/2009/IT/0447 DEEPER, LEADLAB - Leading Elderly and Adult Development – LAB Reference: 502057-LLP-1-2009-1-IT-GRUNDTVIG-GMP 2011 [23][25][43][20]). A new pilot phase would enable empirical validation of the framework and refinement of its methodological and technological architecture, integrating AI technologies.
To ensure feasibility and sustainability of the proposed model, human mediation remains essential. The LPT plays a key role in supporting personalized adult education, also through AI technologies. Formal recognition and institutionalization of the LPT within the professional domain of educators is needed, ensuring standardized competencies, clear roles and effective integration into existing education and training systems. In Italy, this perspective aligns with recent policy developments, such as Ministry Decree No. 328 (December 22, 2022) [37], which introduces roles like the learning personalization tutor and guidance tutor. Building on this framework, the proposed approach is well suited for scalability, adaptation, and extension to other sectors and target groups, including learners with diverse needs such as NEETs or early school leavers.
Finally, mapping environments and generating curricula within a distributed learning ecosystem can support orientation functions, integrating professional outcomes into educational design and aligning with labour market demands. The resulting model, as an adaptive educational infrastructure, could interact with social and economic systems, strengthening the link between education, employability and territorial development.

6. Conclusions

Despite the policy ambition of the European Pillar of Social Rights Action Plan, adult participation in learning remains well below the 60% target for 2030. As highlighted by OECD and European Commission reports, adults still face multiple barriers, including time constraints, limited access to

training, financial costs and dispositional factors such as low self-confidence or negative past educational experiences. These challenges are often compounded by difficulties in navigating complex training systems, especially for adults with already established careers and life routines.
In this context, lifelong learning can no longer be seen as a phase preceding professional life but as a continuous process spanning the entire life course [55]. Educational provision must therefore align with key OECD principles [42]: a systemic vision integrating formal, non-formal, and informal learning; learner centrality; development of learning-to-learn competences and a multi-objective conception of education evolving over time.
From this perspective, a multidimensional pedagogical approach becomes essential. The Complex Learning paradigm offers a coherent framework to interpret dialogical, adaptive, and interconnected learning processes distributed across diverse environments typical of digital ecosystems.
Overall, the framework proposed contributes to the debate on AI-supported lifelong learning ecosystems by integrating ubiquitous environments, personalized strategies and human mediation through the Learning Personalization Trainer. This approach can support more inclusive and adaptive learning infrastructures, addressing structural barriers that still limit adult participation. At the same time, it emphasizes that the primary "technology" to enhance is the human mind itself, in line with the educational vision of John Dewey and, earlier, Aristide Gabelli [17], who promoted the "*strumento testa*" as the foundation of education. Since the early reforms of the Italian school system, this perspective has aimed to foster conscious, responsible citizens capable of autonomous decisions, an objective that remains highly relevant today.

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Continuing Vocational Training of Human Resources: Results of a Longitudinal Survey

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Abstract

The paper focuses on company-provided management training and its determinants utilizing a longitudinal survey of Bulgarian firms conducted between 2020 and 2024. Data has been collected through a standardized interview with firm owners or managers. In addition to training participation, the questionnaire includes a wide range of aspects such as company characteristics, innovation activity, learning culture. Framed with the institutional paradigm, the study estimates the relationship between business investments in management training and three company attributes: size, measured by the number of employees, innovation activity and commitment to learning. To ensure robustness of empirical outputs and conclusions, two alternative estimation methods have been applied – binary logistic regressions as well as non-parametric tests. Stability of the relationships over time has also been assessed by a year term in the models. Empirical analyses indicate that learning orientation is the strongest and most significant predictor of management continuing training. Second, genuine innovations, rather than imitative changes, are correlated with continuing training. A stable positive association exists between industry-wide innovations and management training regardless of firm size while introducing products and services which are new or significantly improved for the company but not for its rivals, does not exhibit a statistically significant effect.

Keywords: *continuing vocational training, management training, firm provided training, innovation, learning culture*

1. Introduction

In today's dynamic world of technological changes and, in turn, new business models, continuing education and training is expected to play a key role for worker labor market competitiveness, company market success as well as national growth prospects. Although the benefits of training have been widely recognised, some countries still lag behind. According to Eurostat, the average percentage of employed people who have participated in continuing education and training across the EU is 43% on average but this number hides the wide differences between the member states ranging from 18.5% in Greece to 83.7% in the Czech Republic. Given these big differentials, it is important to explore to a greater extent the training patterns through country-by-country analyses. Therefore, the current study focuses on firm-provided vocational management training across Bulgarian companies. The research topic is chosen for two reasons. First, Bulgaria is one of the EU countries with lowest involvement of companies in lifelong learning. For example, in 2020, the share of enterprises providing continuing training was only 41.1% compared to 67.4% for the EU-28. Additionally, Bulgarian management is considered less professionally prepared than that in other European countries [1]. According to a study of Ruseva [2] only 53% of Bulgarian managers are aware of the problems and needs faced by their organisations. The present paper extends the scientific research in two directions. It examines a country with low participations in adult learning which might have important policy implications and focuses on determinants of management training particularly – an issue not well developed in the relevant literature. The study utilizes the results of a longitudinal survey comprising three waves – in 2020, 2022, and 2024 respectively. The structure is as follows. Section 2 makes an overview of the theory regarding firm investments in continuing education and training and, on this basis, formulates research questions and hypothesis. Section 3 describes the survey and makes a comparative descriptive analysis across the three rounds. Section 4 presents the empirical models and outputs. Concluding remarks are given in the last section.

2. Determinants of Firm-Provided Training: Theoretical Background in Brief

Firm investment in vocational education and training could be explained in the light of two main views – human capital theory and institutionalism. Training activities are widely regarded as investments in

human capital that enhance productivity, efficiency, and competitiveness. From a rational perspective, firms invest in training only when the expected benefits—such as productivity gains—exceed the associated costs. In a perfectly competitive labor market, employees who receive training would earn higher wages reflecting their increased marginal productivity [3]. Employers are generally reluctant to finance general training, since the acquired skills are transferable and may benefit firm rivals if the employee decides to change his or her job after training. Therefore, companies are willing to invest in firm-specific training, particularly, since the benefits would be retained within the company [4]. Nevertheless, when worker abilities differ and information about training outcomes is imperfect, employers may still finance general training. Firms may offer higher wages to retain high-ability people while encouraging the turnover of the less productive ones [5].

A significant body of research on work-based training is rooted in institutional theory [6]. From this perspective, continuing training is shaped by the inside and outside environment in which the company operate. It can be viewed as a response to formal regulations, industry norms, shared beliefs, and societal values at national, sectoral, or organizational levels. Factors such as trade union presence, organizational culture and ethics, market structures, and processes of institutional change influence firm training decisions [7,8]. Thus, training investments are not determined solely by economic rationality but are embedded in a broader institutional environment. The studies also underline the key importance of organizational factors such as involvement in R&D and innovations; existence of human resource development strategy and practices as well as focus on learning [9,10,11,12]. Sharing of work experiences, learning-oriented culture, appointment of staff responsible for training, private ownership, transparency and fairness in selection of trainees are conducive to lifelong learning in enterprises [13, 14, 15].

Regarding all said above, the current study explores the role of intra-company determinants of firm-provided management training by raising two research questions:

1. Are company attributes such as company size, innovation activity as well as focus on learning related to management training?
2. Are those relationships, if any, stable over time, particularly before and after CoVid-19 pandemics?

The research hypothesis is that firm size, propensity to innovate as well as learning orientation are positively associated with participation in management training.

3. Data and Estimation Method

To test the abovementioned hypothesis, the study uses data from a longitudinal survey of companies operating in the southeastern region of Bulgaria, conducted in three waves: 2020, 2022, and 2024. All samples are representative in terms of firm demographics thus enabling meaningful comparisons across the three rounds to be made. This, in turn, enhances the robustness and reliability of the research findings and strengthens the validity of the conclusions. The data was collected by direct standardized interviews with company manager or owner. The questionnaire comprised a wide range of questions on firm characteristics, policies and practices, including continuing training of managers. The survey was prepared and conducted by a specialized agency which assures its consistency and quality realization.

Table 1. Characteristics of the samples

Survey round	2020	2022	2024
Company's size (number of employees)			
Micro (0-9 employees)	34.7%	38.9%	38.9%
Small (10-49 employees)	33.3%	31.0%	31.0%
Medium and large (50+ employees)	32.0%	30.1%	30.1%
Sector of activity*			
Construction	24,0%	3,5%	4,7%
Trade, repair of motor vehicles and motorcycles	17,3%	14,2%	11,2%
Processing industry	14,7%	23,0%	19,6%
Hospitality industry	4%	20.4%	20.6%
Agriculture, forestry and fishing	13,3%	18,6%	15,0%
Firm-provided continuing training for managers**			
Never	60.0%	51.3%	25.2%
Yes, once	13.3%	18.6%	27.1%
Yes, several times	22.7%	26.5%	37.4%
Yes, by a long-term contract	4.0%	3.5%	10.3%

Training provider			
Individual training specialist	32.0%	18.6%	47.7%
A small company	21.3%	25.7%	19.6%
University/specialised training organisation	6.7%	16.8%	19.6%
NGO	8.0%	8.8%	6.5%
Government organisation	4.0%	7.1%	1.9%

*Only the first three are reported.
**The percentage of respondents answered by "I cannot say" has not been presented here.

Table 1 presents the sample characteristics. More than two-thirds of respondents were micro- or small enterprises with less than 50 employees. The sectoral distribution differs across the three rounds – whereas in 2020 the respondents predominantly operated in the field of Construction (23.8%), Trade, repair of motor vehicles and motorcycles (18.5%), and Processing Industry (16.6%), in 2022 and 2024 the biggest percentage came from Hospitality Industry - 20.4 % and 20.6%, respectively, followed by Processing Industry - 23% in 2022 and 19.6% in 2024, and Agriculture, forestry and fishing – 18.6% in 2022 and 15% in 2024. These differences reflect the change in the sectoral landscape of the Bulgarian economy over the investigated period, and, in turn, ensures representativeness. The number of companies being interviewed is 75, 113, and 107, respectively which accounts for approximately 0.2% of the total number of enterprises in the region per round.
The data shows a clearly expressed upward trend regarding investments in management training. In the first as well as the second round at least 70% of respondents admitted that they had not at all or have only once provided continuing training of managers. For the third round that percentage significantly fell to less than 53%. The percentage of respondents with no training was more than two times lower. Respectively, the share of companies providing management training on long-term contractual basis more than doubled from 4% to 10.3% between 2020 and 2024. The list of the most often used providers includes a training specialist, a small company specializing in training or a university/training organization. The role of the latter in providing management training has been continuously rising over the years from 6.7% during the first wave to nearly 20% in the last survey. Government organisations are rarely selected as trainers.
The main estimation method to test the hypothesis includes binary logistic regressions taking a general form as follows (eq .1):

$$L_i = \ln\left(\frac{P_i}{1-P_i}\right) = B_0 + \sum_{i=1}^{n} B_i\, x_i + \varepsilon_i \qquad (1)$$

The models are estimated on the basis of the results from the first (2020) and the third (2024) round, only. The data for the former was gathered in January 2020, just before the beginning of CoVid-19 crisis. Considering that the two time periods under investigation cover pre- and post-CoVid19 years, the study could, at least indirectly, give some insights into the role of pandemics for training. In all regressions, the dependent variable is a binary variable measuring the existence of firm-provided continuing management training. The variable takes the value of 1 if the company has not provided any management training at all or has participated in training only once. In case of more than one case of management training, the variable equals 2. The regression coefficients (*Bi*) show how the log of the odds ratio changes in case of a unit increase in the factor variable x_i [16]. Alternatively, *Exp(B)* indicates the increase of the odds ratio.
In addition to binary logistic regressions, nonparametric tests are used for assuring the robustness of the results and conclusions – Chi-square test and Mann-Whitney U test. The next section highlights the empirical outcomes.

4. Research Outputs and Analyses

A separate regression was run for each factor of training being tested. The models are of the form (eq. 2):

$$\text{Logit(CTM)}=\beta 0+\beta 1*\text{Xi}+\beta 2*(\text{Xi}*\text{Year})+\beta 3*(\text{Year}) \qquad (2)$$

CTM is the binary dependent variable for continuing management training presented above. Constructed in this way, the specification allows for the stability of the impact of a given factor on training over time to be estimated. The variable *year* takes 0 for the first survey wave (2020), and 1 for the third

one (2024). The size of the enterprise denoted by *firm size* (see, table 1) is measured by a categorical variable which equals 1 for the micro-companies (up to 9 employees), 2 in case of a small or a medium-size company (between 10 and 49 people), and 3 for larger players (50+ employees).
The second training determinant – innovation activity - is defined as an introduction of a product, service, method or process which is new or significantly improved either for the industry or the company. The paper differentiates between its quantity and quality by using two proxies. The binary categorical variable denoted *innovation* (see, table 1) reflects the answers to the question "Did your organization introduced an innovation in the year…" referring to the year preceding the survey. The variable takes 1 in case of a confirmatory answer or 2, otherwise. Alternatively, *innovation scope* is used as a measure of innovation quality. It is a binary categorical variable equal to 1 if the respondent claims that over the two years prior to the survey an industry-level innovation not only for the firm but also for its competitors has happened in products or services being supplied. The variable is coded by 2 if the product/service being introduced was new for the company but not for the market and customers. In case of no innovations, the variable equals 3.
The third training determinant is *learning commitment*. It is a scale variable calculated as an average of three items, each one representing one of the following statements:

1. The ability of employees to learn is a key competitive advantage.
2. Employee training is considered an investment rather than cost.
3. Employee training is a main priority.

Each of the above is measured by a 5-point Likert scale varying from 1 for "Definitely, no" to 5 for "Definitely, yes".

Table 2. Binary logistic regression output

Independent variables	Estimate	St. error	Wald	Sig.	Exp(B)	Goodness of Fit	
						Nagelkerke R^2 p-value	Hosmer–Lemeshow Test p-value
Model 1						0.153	0.911
firm size			6.496	0.039**			
firm size (micro companies)	-1.768	0.747	5.598	0.018**	0.171		
firm size (small companies)	-0.439	0.461	0.906	0.341	0.645		
year	1.636	1.037	2.489	0.115	5.136		
firm size * year	-0.302	0.450	0.449	0.503	0.740		
Model 2						0.091	1.000
innovation	1.030	0.558	3.404	0.065*	0.958		
innovation * year	0.703	0.680	1.067	0.302	2.019		
year	-0.43	1.019	0.002	0.966	0.958		
Model 3						0.206	0.903
innovation scope			6.896	0.032**			
product/service new for the industry	1.191	0.610	3.808	0.051*	3.289		
product/service new for the company only	-0.126	0.483	0.068	0.795	0.082		

innovation scope * year	-0.329	0.394	0.698	0.403	0.720		
year	1.544	0.908	2.889	0.089*	4.683		
Model 4						0.206	0.426
learning commitment	0.631	0.240	6.916	0.009***	1.879		
learning commitment * year	0.147	0.333	0.195	0.659	1.158		
year	0.319	1.321	0.058	0.809	1.376		

***,**,* Statistical significance at 0.01, 0.05 and 0.10 level, respectively

The model goodness of fit is estimated by Hosmer-Lemeshow (HL) test [17] which is widely applied as a standard tool in logistic regressions. A p-value higher than 0.5 implies a failure to reject the null that the model is appropriate in the context of the empirical data. Nagelkerke estimate [18] is a pseudo R-square for generalized linear models ranging from 0 to 1. A value above 0.2 implies a moderate relationship and is considered good fit in the field of social sciences [19].
The regression outputs are presented in table 2. According to the first model, company size is a significant predictor of training, in general (p-value = 0.039). Not unexpected, the negative regression coefficients imply that both micro- and small firms are less likely to provide management training than larger firms. The odds are much lower and statistically significant at 5% level (p-value = 0.018) for micro-firms, particularly. For small companies, the association is weaker and not significant (p-value = 0.341). The positive association is stable over time since the coefficients for *year* as well as the interaction term are not significant. The Hosmer–Lemeshow test has a very high p-value (0.911) indicating that the model performs well. However, Nagelkerke R^2 of 0.153 shows that, although statistically significant, firm size exerts only a weak effect on participation in management training and the model explains hardly 15% of the variance.
Model 2 evaluates the effect of innovation culture on training. It demonstrates a good fit to the data (HL = 1) but its explanatory power is very limited, as indicated by the low value of Nagelkerke R^2 (< 0.10). The regression coefficient for *innovation* is above zero (1.030). This means that companies with innovation in their products, services, methods or processes have higher odds of providing management training in comparison with the competitors which have not recorded any innovation activity. Nonetheless, the higher than 0.05 p-value (0.065) implies marginal statistical significance which suggests a lack of conclusive evidence on the link between innovation quantity and firm investments in management training. Covid-19 crisis has not changed the relationship.

Table 3. Test outputs

Factor	Test	p-value[1]
firm size		
firm's size total effect	Chi-square[2]	0.003***
firm's size (round 1)		0.025**
firm's size (round 2)		0.053*
Cramer's V (round 1) value/p-value		0.313 (0.025**)
Cramer's V (round 2) value/p-value		0.234 (0.053*)
innovation		
innovation total effect	Chi-square	0.108
innovation (round 1)		0.060*
innovation (round 2)		0.400
Breslow-Day test		0.300
Mantel–Haenszel statistics		0.103
innovation scope		
innovation scope total effect	Fisher–Freeman–Halton	0.033**
innovation scope (round 1)		0.000***
innovation scope (round 2)		0.000***
Cramer's V (round 1) value/p-value		0.312 (0.027**)

Cramer's V (round 2) value/p-value		0.378 (0.000***)
learning commitment		
learning commitment total effect	Mann-Whitney U test	
learning commitment (round 1)		0.005***
learning commitment (round 2)		0.001***
Kolmogorov-Smirnov Z (round 1) value/p-value		1.393 (0.041)**
Kolmogorov-Smirnov Z (round 2) value/p-value		1.735 (0.005)***

[1]Group 1 includes enterprises which have never participated in management education and training or those participating only once while group 2 the firms with more management training activity.
[2]Pearson's Chi-square p-value
***,**,*Statistical significance at 0.01, 0.05 or 0.10 level, respectively.

The introduction of a separate variable measuring innovation quality changes the outcome. Wald statistics for model 3 shows that not innovation per se but its scope is a statistically significant determinant of management training (p-value = 0.032). In table 2, the coefficient for the variable titled *product/service new for the industry* is above zero. Moreover, according to *Exp (B),* companies with market-wide innovations have 3.3 times higher odds of training involvement compared to non-innovators. The statistical significance is high given the slightly above the accepted 5% margin p-value (0.051). On the other hand, the impact of firm-level innovations denoted by *product/service new for the company only* is negative and statistically non-significant. The coefficient for *year* is marginally significant at 0.10 but the high p-value (0.403) for the interaction term *innovation scope*year* indicates a lack of evidence that the association has changed during the post-CoVid-19 years. In general, the output reveals that innovations rather than imitations matter for management training. The model exhibits good fit to data with HL near 1 and shows a moderate association between the scope of firm innovations and training incidences.

Since there is a likelihood that due to lower financial and non-financial constraints, higher R&D spending, scale economies as well as market power, larger firms have higher innovative outputs [20], we check if the outcomes of model 2 and 3 result from the positive link between company size and continuing training as model 1 implies. According to the correlation analysis between training participation and each of the two innovation proxies included in model 2 or model 3, both the zero order correlations and partial correlation coefficients with company size used as control are statistically significant. Moreover, the lack of significant correlation between size and innovation indicators used here is in compliance with the non-linear relationship found by some studies. For example, there is evidence that smaller firms have significant potential in product innovations, and in cases of rapid innovation changes [21,22]. So, in this study, the results for the role of innovation performance cannot be explained by firm size.

The third factor – *learning commitment* – is positively linked to firm-provided training (model 4). This is the only coefficient with p-value less than 0.01. Additionally, *year* and the interaction term are not significant (p-value > 0.10) which denotes a stable effect of learning culture on training. Model 4 has moderate explanatory power (p-value = 0.206) and demonstrates a good fit to the data as shown by HL test statistics (p-value = 0.426).

For checking the robustness of the regression outputs discussed above, non-parametric testing has been performed additionally. The results are described in table 3. Chi-square test is employed to the cases of a categorical type factor variable such as firm size, innovation activity or innovation scope. The test results confirm the positive association between larger size and training. However, some slight differences over time have been observed due to the marginal significance for the second round since p-value is slightly above 0.05. Cramer's V statistics is higher than 0.2 denoting a moderate correlation which is a bit lower for the second round.

Regarding the role of innovations, the same as logistic model, the test has not found an overall statistically significant correlation at the 5% level. Chi-square p-value is 0.103. However, during pre-CoVid-19 period, there were some indications for a positive relationship since the p-value is (0.06) is significant at 10% level. A stratified analysis controlling for year was conducted using the Mantel–Haenszel (MH) procedure. The Breslow–Day test indicates that the odds ratios did not significantly differ across years (p = 0.30). The MH shows no significant association between innovation and training after adjusting for year (p-value > 0.10). Overall, no conclusive evidence has been found that the companies declaring some innovation activity are active also in training which is in compliance with the regression outcome above. Contrary to the latter, the statistical analysis once again proves the existence of a robust

stable correlation between the scope of innovations and training involvement. The Fisher–Freeman–Halton exact test is more appropriate in this case because of the small cell counts for the first wave (2020). The total effect is significant at the 0.01 threshold (p-value = 0.033). Cramer's V demonstrates a moderate link between innovation quality and training for the first round (0.312) and moderate to strong effect for the second round (0.378).
To explore the effect of learning culture, Mann-Whitney U test is employed due to the non-normal distribution of *learning commitment* variable and the dichotomous grouping structure. It enforces the outcome of the logistic regression (table 2) by confirming that the organizational focus on human resource development differs significantly between firms with no or very weak management training involvement and those with more intensive participation. The relationship is robust over time as p-value is less than 0.01 for both rounds. The effect size is 0.32 denoting a clearly expressed medium effect. Comparing the four determinants of training being tested, the analysis shows the underlining role of human resource management and the emphasis placed on learning.

5. Concluding Remarks

The aim of this study is to explore the link between selected firm-level attributes and management training. In line with the institutional paradigm, several factors have been included in the econometric specifications: firm size, existence of innovations, innovation scope, and focus on learning. The data comes from two rounds of a field survey conducted with Bulgarian companies. This allows for estimating the stability of the training determinants over time, specifically before and after CoVid-19 pandemics. The outputs suggest a positive significant association between company size and training incidences. Micro-companies are much less likely to provide training to their managers than the large players. Bulgarian firms employing up to 9 people account for nearly 94% of the total number of non-financial enterprises which is a plausible explanation of the low country involvement in firm-sponsored adult learning.
Regarding the second training determinant, the results differ according to the innovation indicator being applied. Introduction of an innovation, though positively related to training, lacks statistical significance at the 0.05 level. While not entirely foreseen, this outcome is explainable considering the broad definition of innovation used here. The latter encompasses any introduction of new or significantly improved products, services, methods, or processes in an organization. Once the quality of innovation is estimated, the effect becomes statistically significant. A stable positive link emerges between the scope of innovations and management training with innovation leadership acting as a catalyst of business investments in training. This outcome is consistent with the resource-based view [23] which sees learning as a key strategic organizational asset. On the other hand, there is no conclusive evidence regarding the effect of firm-only innovations. The study suggests that regular management training is offered by companies with genuine innovations, rather than imitative ones, regardless of firm size. The final factor being tested is learning orientation. Here, it is approximated by respondent perception of learning as a main source of competitive advantage and a key priority for the company. Both the binary logistic regression and the non-parametric test provide evidence of the essential role of learning commitment.
Overall, the current study fully confirms the hypothesized relations regarding firm size as well as learning orientation, while partially justifying the role of innovation performance. Moreover, it underlines the primary importance of learning culture and market-wide innovations of product or services produced by the firm. Thus, the research findings are in line with resource-based view and institutional theory.
The paper has some practical implications for public policy in adult learning. The government should direct its efforts to create incentives for micro-firms to invest in staff training given the financial constraints which such organisations likely face. According to a field study on continuing vocational education and training across Bulgarian companies conducted in 2024 [24], the three most effective measures of government support include direct subsidies from government budget covering all the associated expenses for 34% of respondents, national or European projects (23%), direct subsidies covering part of training spending (15%). Such measures might lead not only to human capital accumulation but also to higher firm potential to innovate. The reverse effect of training on innovation capacity needs to be further examined.

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Acting Together in Prehospital Care: Qualitative Insights into an Interprofessional Trauma Training Program

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Abstract

Effective trauma care necessitates a high level of interdisciplinary coordination between paramedics and physicians. In response to this requirement, an eight-hours interprofessional training program was implemented in 2025 at a German educational institution to enhance collaborative competencies in prehospital trauma management. The educational concept was grounded in experiential learning theory and integrated simulation-based scenarios with structured reflection phases. The aim of this study was to explore participants' experiences with the didactic concept and their perceptions of its realization. A qualitative, exploratory research design was applied. Following the training, eight semi-structured interviews were conducted with participating paramedics (n=5) and physicians (n=3). Data was analyzed using qualitative content analysis according to Mayring [1]. Analytical emphasis was placed on identifying key experiential dimensions related to instructional design, team interaction, interprofessional collaboration, and the training's perceived relevance for clinical practice. Participants described the training as highly relevant, motivating, and conducive to effective learning. Authentic case simulations were perceived as particularly valuable in illustrating the necessity of interprofessional coordination during emergency response. Structured reflection phases were highlighted as essential for consolidating knowledge and facilitating metacognitive awareness. Tensions related to professional hierarchies and distinct role perceptions emerged but were constructively addressed through the reflective and interactive design of the training. Findings indicate that intentionally designed, simulation-based learning environments can significantly foster interprofessional collaboration and action competence in prehospital trauma care. The study underscores the importance of reflective, practice-oriented didactic models in strengthening interprofessional teamwork and decision-making under emergency conditions.

Keywords: *Interprofessional training, Prehospital trauma care, Simulation-based learning, Experiential learning, Qualitative research*

1. Introduction

Prehospital trauma care places the highest demands on the competence and capacity for action of the health professions involved. Severe trauma ranks among the leading causes of death worldwide, particularly among younger populations [2], and requires coordinated, time-critical care by interprofessional teams immediately following the event. In the German emergency medical services system, emergency physicians and paramedics work closely together within a physician-led framework. The competencies and scope of practice of both professional groups are defined by the legal framework set out in the emergency services legislation of the respective federal states [e.g. 3] and by the Emergency Paramedic Act (Notfallsanitätergesetz) [4]. Despite this structural connection, interprofessional training formats that address both professional groups jointly and on equal terms remain underrepresented in the practice of initial and continuing education [5]. The quality of interprofessional collaboration in emergency situations has, however, been demonstrably shown to have a direct influence on patient outcomes: unclear role distribution, deficient communication, and hierarchy-related interaction problems are considered key risk factors for errors and gaps in care in prehospital acute care settings [6, 7, 8].
Simulation-based interprofessional training formats offer a promising pedagogical approach to addressing these challenges, as they enable realistic learning experiences under controlled conditions and specifically promote the development of shared clinical competence [7, 9, 10]. Against this background, an eight-hour interprofessional training program for prehospital trauma care was developed in 2025 and piloted during a continuing education event in Pirna, Germany. The program combines simulation-based scenarios with structured reflection phases. The aim of the present study is to qualitatively capture participants' experiences with the didactic concept of the program and to examine

their perceptions of its implementation. The findings are intended to contribute to establishing evidence-based foundations for the further development of interprofessional training concepts in emergency medical services.

2. Background

The didactic concept of the training program under investigation is grounded in two complementary theoretical pillars: Kolb's Experiential Learning Theory [11] and the principles of interprofessional education (IPE) [9, 12, 13]. Both approaches are mutually reinforcing in their pedagogical orientation and together provide a coherent framework for the design and analysis of simulation-based interprofessional learning formats in healthcare.

2.1 Theoretical Approaches

Experiential Learning and Simulation-based learning
Kolb describes learning as a cyclical process comprising four successive phases: concrete experience, reflective observation, abstract conceptualization, and active experimentation [11]. Learning takes place not through passive absorption of knowledge, but through the active transformation of experience into action-relevant cognitive structures. The reflective phase occupies a key role: it fosters metacognitive competencies and enables the transfer of situated experiential learning into generalized knowledge. This is a capability of particularly high practical relevance in dynamic emergency settings [14, 15].
Simulation-based learning (SBL) is well-supported by empirical evidence in health professions education as a tool for fostering clinical and team-based competence [6, 7, 10]. It creates authentic learning experiences under controlled, psychologically safe conditions, making it particularly suitable for complex, time-critical care contexts such as emergency medicine. Within the framework of the Kolb cycle, simulation fulfills the function of concrete experience: it generates emotional and cognitive engagement and activates procedural knowledge. Decisive for learning effectiveness, alongside scenario fidelity, are above all structured debriefing and reflection phases, which have been demonstrably shown to contribute to the consolidation of learning outcomes and the development of collective reflexivity. In this context, debriefing is understood not merely as a post-activity review, but as an independent pedagogical intervention that bridges the gap between concrete experience and abstract conceptualization [6].

Interprofessional Education (IPE)
According to the definition of the World Health Organization (WHO), interprofessional education refers to that form of learning which occurs when members of two or more health professions learn from, with, and about each other [16], with the aim of enabling improved collaboration and patient care. IPE is therefore not merely an organizational format, but a pedagogical program aimed at overcoming profession-specific tunnel vision, fostering mutual appreciation, and developing shared action orientations. The scientific evidence demonstrates that well-designed IPE formats not only positively influence attitudes toward other professional groups, but also measurably promote practical collaborative competencies, such as shared decision-making, structured communication, and a shared awareness of professional roles [5-9]. In emergency medicine, where effective teamwork is directly linked to patient safety, efforts are underway to establish IPE as a component of evidence-based continuing professional development [17, 18].

2.2 Simulation-based Interprofessional Training for Prehospital Trauma Care

The theoretical foundations outlined above constitute the conceptual frame of reference both for the design of the present training program and for the analytical perspective of this study. Their application to the context of prehospital trauma care requires a context-sensitive adaptation that takes into account the structural specificities of the German emergency medical services system.
The simulated trauma scenarios of the program served as the primary experiential anchor in the sense of the first phase of the Kolb cycle. Their authenticity was designed to generate emotional and cognitive engagement, thereby creating preconditions for deeper reflection. The immediately subsequent structured reflection phases assumed the function of the second and third cycle phases: they supported participants to observe what they had experienced, identify patterns, and draw conceptual conclusions. The sequential arrangement of multiple scenarios additionally operationalized the fourth phase (active experimentation) by enabling participants to trial new action strategies immediately [11].

A particular area of tension concerns the structurally embedded hierarchies between emergency physicians on the one hand and paramedic personnel on the other. The German emergency medical services system is traditionally physician-led, and despite the expanded scope of practice introduced by the Emergency Paramedic Act (Notfallsanitätergesetz) [4], the scope of action of both professional groups remains clearly defined by law. Such structural asymmetries are frequently reflected in interaction patterns and communication styles and can substantially affect the quality of interprofessional collaboration. The program therefore pursued the explicit goal of creating a learning space in which both professional groups could engage as equals and jointly reflect on their respective understandings of their professional roles. The combination of IPE principles with Kolb's reflection-oriented didactic approach made it possible not to suppress these hierarchical tensions, but to engage with them constructively as productive learning material [11, 19, 20].
The present qualitative study focuses on this process of translation into practice. The analytical categories of (a) didactic concept, (b) team interaction, (c) interprofessional collaboration, and (d) perceived practical relevance reflect the theoretical target dimensions of experiential learning and IPE, and form the basis for the qualitative data analysis.

3. Data Collection and Analysis

A total of N=23 individuals participated in the training program (paramedics: n=15; emergency physicians: n=8). Data collection was conducted in September 2025 with eight participants of the interprofessional training program, including five paramedics (n=5) and three emergency physicians (n=3). Participants were selected according to the principle of purposive sampling in order to ensure the inclusion of both professional groups. Semi-structured short interviews were conducted immediately following the training. The interview guide was oriented toward the central analytical categories of the study: the didactic concept and its implementation, team interaction within the scenarios, the experienced interprofessional collaboration, and the perceived practical relevance of the training. Participation in the study was voluntary. With participants' informed consent, the interviews were digitally recorded, subsequently transcribed verbatim, and pseudonymized for analysis purposes (paramedics: P1 - P5; emergency physicians: P6 - P8).
Data analysis was conducted using qualitative content analysis following Mayring [1] and pursues an exploratory approach. The procedure was designed as a deductive-inductive process: the superordinate analytical categories were developed in advance on a deductive basis, grounded in the theoretical framework, while the subcategories were formed inductively from the data material. Transparency of the analytical process was ensured through comprehensible documentation of the category formation procedure. Intercoder reliability was secured through independent coding runs and consensual validation.

4. Results

The qualitative content analysis of the interview material yielded four superordinate categories, which were developed deductively on the basis of the theoretical framework and further differentiated through inductively formed subcategories. Table 1 below provides an overview of the category system:

Table 1. Overview of the Category System of the Qualitative Content Analysis.

Category	Subcategories
A – Didactic Concept and Implementation	• Structuring of the workflow • Perceived facilitation of learning
B – Team Interaction	• Communication behavior • Task distribution within the scenario • Dynamics under time pressure
C – Interprofessional Collaboration	• Role understanding • Hierarchical tensions • Mutual professional appreciation
D – Practical Relevance	• Transfer to professional practice • Confidence in clinical action

4.1 Category A: Didactic Concept and Implementation

The didactic concept of the training program was consistently rated positively by the participants. Particular emphasis was placed on the high degree of realism of the simulated scenarios and the clear structure of the eight-hour program. The authenticity of the case design proved to be a central factor in the perceived learning effectiveness: participants reported that the setting generated emotional involvement and made the seriousness of the situation tangible. Structured reflection phases following the scenarios were described as didactically indispensable, as they provided the opportunity to analyze clinical workflows and collectively identify areas for improvement.

- *"The cases were designed in such a way that you really had the feeling that this could happen exactly the same way tomorrow. That helped me to engage fully." (P3, paramedic)*

- *"The reflection round afterwards was the most valuable part for me. It was only then that I became aware of what I had actually been thinking in that situation and why." (P7, emergency physician)*

The combination of simulation and structured reflection corresponded to the experience of a complete learning cycle: participants described how the sequence of scenarios enabled them to progressively develop new action strategies and immediately apply them in the subsequent scenario.

4.2 Category B: Team Interaction

The analysis of the interview statements on team interaction revealed that collaborative action under time pressure was perceived as particularly instructive. Participants addressed both successful coordination processes and moments in which communication gaps or unclear task distribution temporarily impaired the team's ability to act. These critical moments, however, were not experienced as failure but rather as productive learning opportunities, particularly when they were explicitly addressed during debriefing.

- *"In the first scenario, we were talking past each other. Nobody knew exactly who was supposed to do what. But that is precisely what we unpacked in the debriefing, and the second time around it went noticeably better." (P1, paramedic)*

- *"I realized how important it is to clearly communicate what I need next. That sounds trivial, but under pressure you forget it quickly." (P6, emergency physician)*

The analysis revealed that team interaction in the simulation context was experienced not only as a domain of competence but also as a mirror of everyday behavioral patterns. The training thus created a space in which both well-established and partially problematic interaction behaviors became visible and accessible to reflection.

4.3 Category C: Interprofessional Collaboration

This category proved to be particularly rich and multifaceted. Participants described an initial field of tension between the two professional groups, resulting from differing role understandings, professional socialization processes, and established hierarchical expectations. Both paramedics and emergency physicians reported an initial sense of uncertainty in their interactions with the respective other professional group within the simulation context. Over the course of the training, in particular through the shared reflection phases, this perception shifted. Participants developed a more differentiated understanding of the competencies and perspectives of the other profession.

- *"At the beginning, I thought: the emergency physician will handle it, I'll hold back. But during the debrief it became clear to me that my knowledge is equally in demand and needed." (P2, paramedic)*

- *"I was surprised by how much the paramedic colleagues contribute. That made me realize that in real practice I perhaps listen too little." (P8, emergency physician)*

The hierarchical tensions were not resolved by the reflective-interactive design of the training, but were made constructively workable. Participants described the shared learning space as an experience in which professional equality was not presupposed but actively negotiated.

4.4 Category D: Practical Relevance

The participants described the training as highly relevant to their professional practice. They emphasized that the competencies acquired (e.g., more structured communication, clear role assumption, and shared decision-making under time pressure) were directly transferable to everyday operational practice. Several participants expressed a desire for regular repetition of this kind of training as well as for its extension to additional professional groups within the emergency medical services system.

- *"Training like this should be mandatory. In eight hours, I learned more about actual collaborative work than in four years of operational practice." (P4, paramedic)*

- *"This showed me where I still have gaps in my communication skills with the paramedic team. That is something I am taking away with me." (P5, emergency physician)*

The transferability of the training was closely linked by participants to its practical relevance: the experience of the learned content being directly applicable was described as a key factor in its usefulness in daily work and as a contribution to enhancing confidence in clinical action.

5. Discussion and Conclusion

The findings of the present study indicate that a reflective simulation-based interprofessional training program can effectively promote the collaborative competence of paramedics and emergency physicians in prehospital trauma care. The positive evaluation of the didactic concept corresponds with the evidence in international literature, which identifies the combination of case simulations and structured debriefing phases as particularly effective for learning [7]. The reflection phases served as significant bridging function between concrete experiential action and conceptual understanding.
The identified communication gaps and coordination problems under time pressure correspond to structural findings from interprofessional emergency research, which identifies unclear role distribution and the absence of feedback routines as central sources of error in acute care [21]. It is significant that participants experienced these deficits as amenable to change through the formalized debriefing process. This points to the pedagogical effectiveness of reflective learning spaces in highly complex care contexts.
The hierarchical tensions reported between the two professional groups are structurally embedded in the German emergency medical services system. While the training program was unable to resolve these tensions, it created the conditions necessary to address them constructively and to develop mutual professional understanding. This underscores that interprofessional competence cannot be presupposed but must be actively cultivated through deliberately designed learning formats.
The study has methodological limitations: the small sample size, the absence of a longitudinal perspective, and potential social desirability effects limit the generalizability of the findings. Future studies should incorporate follow-up assessments and quantitative methods in order to validly capture transfer effects into clinical practice.
The findings provide an empirical basis for the further development of interprofessional training formats in emergency medical services and underscore the educational policy imperative to establish such formats as a permanent component of continuing professional development and advanced training.

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Investigating Secondary Mathematics Teachers' Confidence Levels after Attending Voluntary Professional Learning

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Abstract

The supply of secondary school mathematics teachers (SSMTs) in Australian schools is a problematic issue [1]. To address this issue, one effort conducted at scale involves providing professional learning (PL) for teachers of Years 7-10 mathematics, so that they are competent and qualified to teach mathematics courses to Year 11 and 12 students. PL is viewed as the processes by which teachers acquire new knowledge, skills, affects, and/or develop behaviors [2], which ultimately lead to improved student outcomes [3]. Presented at the conference are the findings of a survey where 73 SSMTs completed immediately before and again, immediately after, they participated in an intensive PL course. The survey interrogated the extent to which SSMTs felt confident to teach mathematical content following their PL course participation. For one survey question with six items, mean confidence scores were calculated, and pre-post PL changes in confidence levels were assessed across mathematics courses and year levels using a linear mixed model [4]. Results indicated SSMTs' confidence levels improved after completion of all PL courses, with teachers in the Year 11 courses having higher confidence levels than those attending the Year 12 courses. No significant difference was detected for Mathematics Methods versus Specialist Mathematics courses.

Keywords: *Secondary mathematics teachers; Professional learning; Confidence*

1. Introduction

Australia has experienced problems with the supply of secondary mathematics teachers for several decades, evidenced in out-of-field (OOF) teacher rates and increasing student enrolments in secondary schools [1]. Efforts to ameliorate this issue have included pre-service mathematics teacher training [5], the provision of professional development (PD) for in-service teachers, and professional learning (PL) for OOF [6]. According to some authors [1], one suggestion is that teachers of Years 7-10 be encouraged to progress to Years 11 and 12, through collaboration across discipline and education professionals. Within this paper, the confidence levels of secondary school mathematics teachers (SSMTs) participating in voluntary PL will be outlined. PL is viewed as the processes by which teachers acquire new knowledge, skills, affects, and/or develop behaviours [2], which ultimately lead to improved student outcomes [3]. The significance of this study is underpinned chiefly by the premise that quality teaching impacts student learning positively [7]. Accordingly, school leaders and systems have focused on implementing quality teaching practices and accessing PL which supports these practices [8].

1.1 Research Question

The main research question addressed in this paper is: To what extent does SSMTs' participation in voluntary PL courses affect their confidence to teach mathematical content?

2. Research Design

2.1 Context

In response to the need for secondary mathematics PL, the Department of Education Western Australian (DoE) offers PL courses in senior secondary mathematics to SSMTs. The lead author has delivered perennially the following intensive, short PL courses to current DoE SSMTs from 2020-2022; Year 11

Mathematics Methods [11MAM], Year 11 Mathematics Specialist, Year 12 Mathematics Methods, and Year 12 Mathematics Specialist [see School Curriculum & Standards Authority (SCSA)], [9]. Over the 3-year period, 73 SSMTs participated in pre-course surveys, post-course surveys, and individual interviews. Reported in this paper are the analysed confidence results from the pre- and post-course surveys (see Instrument).

2.2 Instrument

SSMTs were invited to complete a pre-and post-course survey for every PL course they participated in. The survey items for each PL course were identical except for Question 3. All PL surveys listed six course topics at Question 3 which were developed according to the content for respective courses [9]. Respondents rated their confidence to teach mathematics topics according to a 5-point Likert scale. To illustrate, Question 3 of the pre-course survey for 11MAM is presented below.

Currently, how confident are to you feeling to competently teach the following Year 11 Mathematics Methods course topics (1 = Not Confident at all, 2 = Slightly Confident, 3 = Somewhat Confident, 4 = Fairly Confident, 5 = Completely Confident):					
• Functions and graphs	1	2	3	4	5
• Trigonometric functions	1	2	3	4	5
• Counting and probability	1	2	3	4	5
• Exponential functions	1	2	3	4	5
• Arithmetic and geometric sequences and series	1	2	3	4	5
• Applications to differential calculus	1	2	3	4	5

3. Statistical Analysis

A total confidence score was calculated by summing the six Likert scale items at Question 3 for each PL course. Scores could range from a minimum of six to a maximum of 30. A mean item score was calculated (total score/6). Cohen's d effect sizes were computed for individual items, and magnitude was interpreted as no effect (0.0-0.1), small effect (0.2-0.4), intermediate effect (0.5-0.7), and large effect (≥0.8). A linear mixed model was used to investigate the change in confidence levels (mean item score, dependent variable) across mathematics course (Methods/Specialist), year level (11/12) and course evaluations (pre-/post-PL course), treated as fixed factors, and anonymous identifier treated as a random effect. Tests of fixed effects (F and p-value) are reported. Residuals were assessed and assumptions met with a normal distribution (Shapiro-Wilk=1.0, p=.166). IBM Statistical Package for the Social Sciences Statistics Version 29.0 was used for the data analysis [10].

4. Results

Over a period of 3 years, 167 SSMTs attended one of four PL courses. A total of 133 pre- and post-responses were collected from participants across that period, with a response rate of 39.8%. For each professional learning course, SSMTs' reported confidence levels increased (Fig. 1). Across course topics, all but three course topics reported intermediate or large effect sizes (Fig. 2).

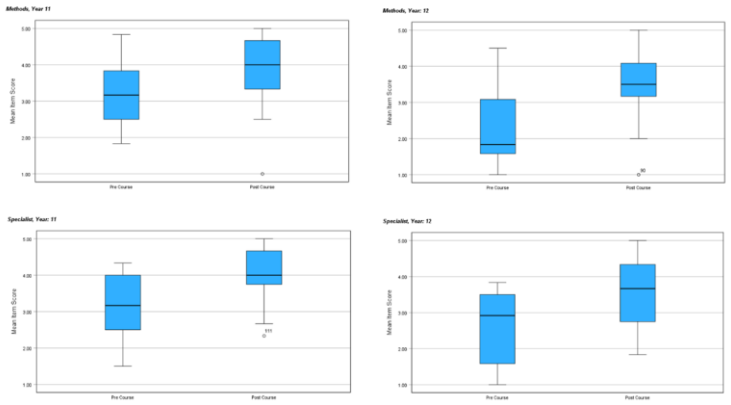


Fig. 1. Confidence levels (mean item score) to competently teach mathematics course topics, separated across course, year level and pre- and post- professional learning course attendance.

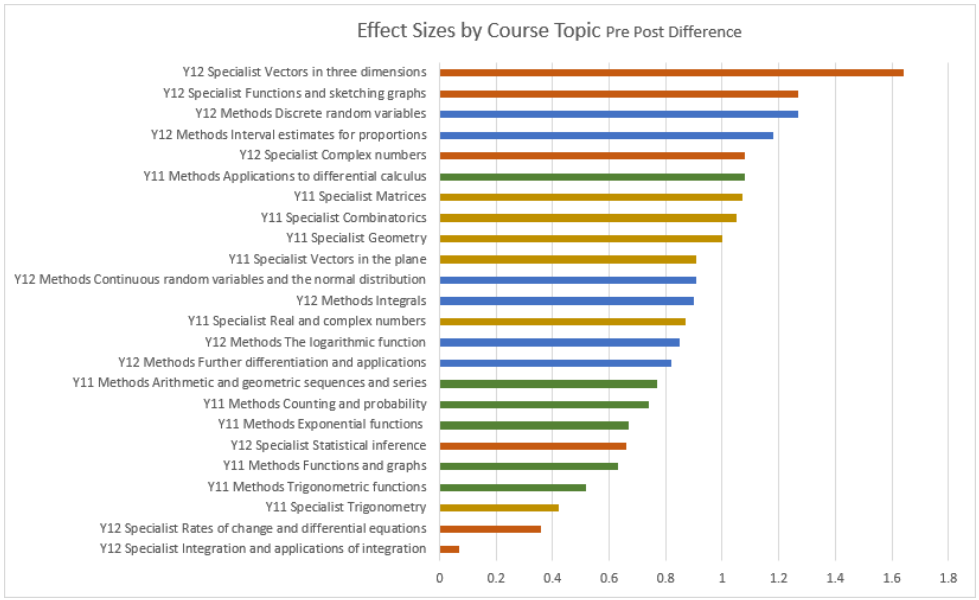


Fig. 2. Pre- and post- effect size differences by professional learning course topic.

Linear mixed modelling [4, 11] found SSMTs' confidence levels improved after completion of the PL program ($F=32.2$, $p<.001$), with teachers in the Year 11 programs having higher confidence levels than those attending the Year 12 courses ($F=10.6$, $p=.001$). No significant difference was detected for Methods versus Specialist courses ($F=0.4$, $p=.553$). Mean differences are summarised in Table 1.

Table 1. Linear mixed model means confidence level differences for pairwise comparisons of mathematics unit, year level and pre and post course.

Calculation	**MD**	**SE**	**p-value**	**95% Confidence Interval for Difference**	
				Lower Bound	Upper Bound
Specialist-Methods	0.1	0.2	.553	-0.3	0.5
Year 12-Year 11	-0.6*	0.2	.001*	-0.9	-0.2
Post-/Pre-Course	1.0*	0.2	<.001*	0.6	1.3

N.B. Based on linear mixed model with the dependent outcome mean item score, degrees of freedom =122.
***bolded** statistical significance at $p<.05^a$ Bonferroni adjustment for multiple comparisons [MD Mean difference, SE standard error].

5. Conclusion

This survey reported a positive effect where SSMTs felt confident to teach mathematical content following their PL course participation. Teachers participating in the Year 11 courses had higher confidence levels than those attending the Year 12 courses, which likely represents the level of mathematical difficulty involved. No significant differences were detected for Methods versus Specialist courses, which probably indicates that the affordances of PL are similar for both mathematics courses. Effect sizes suggest that SSMTs may benefit from PL focused on certain mathematics topics more than others. This study supports the value of PL for improving quality teacher practice which should translate into quality learning outcomes for students.

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From Anticipated to Emergent Risks: Lessons Learned from Designing a Joint Master's Programme in Low-Carbon Structural Engineering

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Abstract

The development of joint and integrated master's programmes within international consortia involves complex academic, institutional, and regulatory challenges. This paper reflects on risk assessment and risk materialisation within the Low Carbon Structures (LowCarb-S) project, an Erasmus Mundus Design Measures action aimed at developing a future joint master's degree in sustainable structural engineering across six European universities. During the proposal phase, a structured risk analysis was conducted to anticipate challenges related to curriculum harmonisation, alignment of learning outcomes, accreditation procedures, institutional engagement, and governance. Although these risks were formally identified and mitigation strategies proposed, the programme development phase revealed notable discrepancies between anticipated and actual risks. Several challenges evolved differently than expected, and additional risks emerged. Key emergent risks included divergent national accreditation cultures, varying interpretations of sustainability and low-carbon competencies, differences in institutional readiness for joint degrees, and difficulties in translating strategic educational objectives into coherent and assessable curricula. Moreover, interdisciplinary integration—central to the programme's ambition—introduced a level of complexity that was underestimated at proposal stage. By contrasting projected and real risks, this paper highlights the limitations of conventional proposal-stage risk assessments and emphasises the need for adaptive and process-oriented risk management throughout joint programme design. The findings provide practical insights for academic leaders and project coordinators involved in Erasmus Mundus initiatives, European University alliances, and the development of innovative, sustainability-oriented engineering programmes.

Keywords: *Joint degree, Erasmus Mundus, curriculum development, risk assessment, low-carbon structures, higher education*

1. Introduction

As the transition toward a greener and more digital society accelerates, the construction sector faces increasing pressure to balance sustainability, competitiveness, and innovation. The European Union has set ambitious targets through initiatives such as the European Green Deal [1] and the Fit for 55 package [2], aiming for climate neutrality by 2050 and significant reductions in CO_2 emissions. Complementary measures, including the Net-Zero Industry Act [3] and the Carbon Border Adjustment Mechanism [4], seek to support industrial transformation while maintaining fair competition. These policies are driving a shift toward low-carbon materials, improved energy efficiency, life cycle-based design approaches in construction, and industry initiatives such as CEMBUREAU's Net Zero Roadmap [5].

At the same time, the EU's digital strategy highlights the need to enhance digital skills and increase the adoption of advanced technologies such as artificial intelligence. Despite their potential, uptake remains limited, with only 54% of adults possessing basic digital skills [6,7] and a relatively low adoption of AI in enterprises, particularly in the construction sector [8]. Alongside the green and digital transitions,

education plays a critical role in supporting innovation and competitiveness. However, disparities persist in participation and attainment levels, with only 47% of European adults engaged in learning activities [9] and 23% attaining tertiary education degrees [10]. EU policy frameworks, including the European Pillar of Social Rights Action Plan [11], aim to address these gaps, although differences across fields remain evident [12].

In response to these interconnected challenges, the Low Carbon Structures Joint Master's Degree (Acronym LowCarb-S) is being developed as an interdisciplinary programme bringing together six European universities. The development of the programme is funded by the European Union through the Erasmus Mundus Design Measures (EMDM) financial scheme. The programme integrates sustainability, digitalization, and AI-driven design within a flexible, modular structure that enhances accessibility while maintaining academic rigor.

The development of joint and double degree programmes has been widely recognised in the literature as a key instrument for advancing internationalisation and institutional cooperation in higher education. However, previous studies consistently highlight that such programmes are inherently complex and often affected by structural, legal, and organisational challenges that extend beyond purely academic design. Evidence shows that difficulties related to accreditation, recognition of qualifications, funding sustainability, and curriculum integration are among the most frequently reported obstacles in transnational programme development [13,14].

Moreover, research conducted at European level indicates that joint programmes operate within highly heterogeneous institutional and regulatory environments, where differences in national systems and institutional practices significantly influence implementation processes and outcomes [15,16]. These findings suggest that the success of joint master's programmes depends not only on academic excellence, but also on the ability to manage institutional diversity and coordination complexity.

This paper examines the gap between anticipated and actual risks in the development of the Low Carbon Structures (LowCarb-S) joint master's programme. Beyond a descriptive comparison, it aims to provide a critical reflection on the limitations of proposal-stage risk assessment in complex, multi-institutional academic projects. The paper argues that risk in such contexts is not primarily technical, but emerges from institutional diversity, governance complexity, and uneven partner engagement. By analysing how initially identified risks evolved and how new risks emerged during implementation, the study contributes to a more process-oriented understanding of risk management in joint programme design. While not aiming for statistical generalisation, the study offers practical and conceptual insights for academic leaders and project coordinators involved in Erasmus Mundus initiatives, European University alliances, and the development of interdisciplinary, sustainability-oriented programmes.

This study adopts a qualitative case-study approach based on the implementation of the LowCarb-S project. The analysis is grounded in the comparison between proposal-stage risk assessment and mid-term implementation dynamics, using internal project documentation, coordination meetings, and progress monitoring activities as primary sources of evidence.

2. Description of the Low Carbon Structures (LowCarb-S) Joint Master's Programme

The Low Carbon Structures (LowCarb-S) Joint Master's Degree is an interdisciplinary initiative developed by a consortium of six European universities: Technical University of Cluj-Napoca (TUCN), Cyprus University of Technology (CUT), Riga Technical University (RTU), University of Cassino and Southern Lazio (UNICAS), Technological University Dublin (TUD), and University of Montenegro (UoM). Each institution contributes complementary expertise in sustainable construction, structural engineering, digitalization, and artificial intelligence, supported by specialized laboratories and research facilities. It is designed to respond to the growing need for engineers capable of addressing climate change challenges through low-carbon design, life cycle optimisation, and the integration of digital tools such as AI-driven modelling.

The project is guided by several core objectives in alignment with Erasmus Mundus Design Measures requirements. Figure 1 details the objectives of the LowCarb-S project:

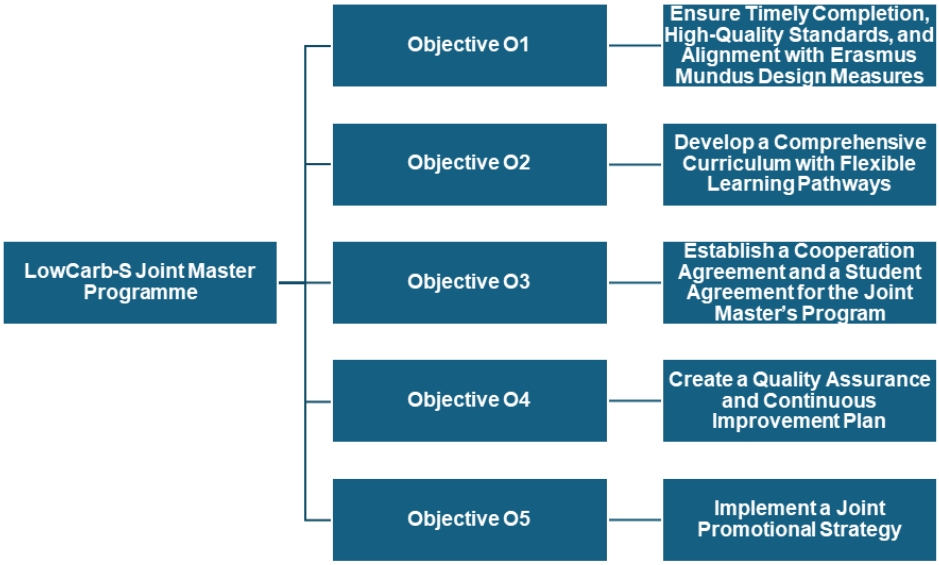


Fig. 1. LowCarb-S Core Objectives

The achievement of these objectives may be affected by a range of risks, including institutional, regulatory, and operational challenges, which can influence both the implementation process and the overall outcomes of the programme.

3. Risks in the Proposal Phase vs. the Development Phase at the Mid-point Implementation Period

During the proposal phase, a structured risk assessment was conducted to identify potential challenges that could affect the achievement of the project objectives and to define appropriate mitigation measures, which is presented in Table 1. The risks were classified as having either high or medium impact on the implementation of the project proposal.

Table 1. Risks in the proposal phase with corrective measures

Risk No	Description	Proposed risk-mitigation measures	Affected Objectives
R1	Differences in academic structures, credit recognition policies, and institutional priorities may hinder the development of a cohesive joint master's programme. Risk: High impact.	1. Establish a structured governance and coordination framework early in the project. 2. Conduct regular consortium meetings to align expectations and resolve conflicts. 3. Ensure adherence to European Higher Education Area (EHEA) qualification frameworks for uniformity across institutions.	O1, O2, O3, O4
R2	Lengthy administrative processes in partner institutions may delay curriculum validation and approval. Risk: Medium impact.	1. Develop a pre-accreditation compliance checklist to anticipate and address approval challenges. 2. Establish clear responsibilities for each partner in securing internal approvals.	O1, O3, O4
R3	Designing an interdisciplinary programme that integrates expertise from multiple universities while ensuring academic coherence can be complex. Risk: High impact.	1. Define common learning outcomes based on partner expertise and industry needs. 2. Ensure flexibility through modular course structures that accommodate different institutional requirements.	O2
R4	A lack of engagement from industry partners and external stakeholders may reduce the programme's practical relevance. Risk: Medium impact.	1. Establish advisory boards with representatives from industry and research institutions. 2. Align curriculum with industry needs through consultations and workshops.	O2, O5

		3. Incorporate practical case studies and industry-driven challenges into course design.	
R5	Without an effective dissemination strategy, the proposed master's programme may struggle to attract strong institutional and student interest. Risk: High impact.	1. Develop a strategic marketing plan that highlights the programme's unique value. 2. Address existing university networks, Erasmus+ platforms, and academic conferences to promote the initiative.	O5
R6	Unforeseen financial limitations or bureaucratic hurdles could impact the project's ability to finalize the programme design. Risk: Medium impact.	1. Establish a detailed and transparent financial management plan with contingency funds.	O1, O3, O5
R7	The joint master's programme may not secure sufficient funding or institutional commitment for future implementation. Risk: High impact.	1. Secure institutional commitments from partners regarding future resource allocation. 2. Search potential funding sources, including Erasmus Mundus Joint Master (EMJM) funding.	O3, O5

At the mid-point of project implementation, the development of the LowCarb-S programme reveals a mixed progress pattern, with discrepancies between planned and actual achievements, thus confirming the relevance of several risks identified during the proposal phase.

On the academic side, ~~i~~several key steps have been completed. The overall programme structure has been agreed (four semesters, 120 ECTS), alongside a decentralized accreditation approach, whereby each partner will pursue national accreditation in line with domestic regulations. Additionally, stakeholder engagement has been initiated through the design of questionnaires targeting employers and employees, focusing on sustainability, green practices in construction, and digitalization needs. Final learning outcomes have also been defined, and the consortium has initiated the process of aligning existing courses within each institution to these outcomes—an essential step given the constraints related to future Erasmus Mundus Joint Master (EMJM) applications.

However, progress has been slower than initially planned in several areas. The curriculum development process, while conceptually advanced, has been affected by institutional differences and varying interpretations of legal and procedural constraints. This situation directly reflects Risk R1 (differences in institutional frameworks) and Risk R3 (complexity of interdisciplinary curriculum design), while also highlighting additional layers of legal sensitivity not fully anticipated at proposal stage.

Furthermore, limited progress has been recorded in the development of joint governance instruments, such as joint policies and agreements, primarily due to time constraints among responsible partners. This aligns with Risk R2 (administrative delays) and Risk R6 (organizational and resource-related constraints), demonstrating how competing institutional priorities can impact coordination efforts.

In contrast, dissemination activities have progressed effectively. The consortium has successfully developed a visual identity, communication templates, social media presence, a dedicated website and promotional materials for the first project onsite event. Furthermore, the project was already presented in an international conference and more scientific disseminations are ongoing, in accordance with the project proposal. These outcomes indicate that mitigation measures associated with Risk R5 (dissemination and visibility) have been successfully implemented.

Regarding partnership formalization, although partner agreements have been drafted to regulate financial distribution—given that the Technical University of Cluj-Napoca (TUCN) acts as the main beneficiary—only partial signature completion has been achieved to date, with the agreement finalized by the University of Montenegro (UoM), Cyprus University of Technology (CUT), and University of Cassino and Southern Lazio (UNICAS). This situation reflects elements of Risk R7 (insufficient institutional commitment) and highlights delays in formal engagement across the consortium.

Overall, the current stage of implementation demonstrates that while strategic academic components are advancing, operational, legal, and institutional factors are generating delays and reshaping the initially anticipated risk landscape. These findings demonstrate the need of adaptive and continuous risk management beyond the proposal phase.

Table 2 presents the risks identified in the project proposal and the updated corrective measures required to bring the project back on track.

Table 2. Risks in the proposal phase encountered in the development phase and updated corrective measures at mid-point project

Risk No	Encountered (Yes/No)	Updated corrective measures adopted at the project mid-point
R1	Yes	Organize targeted bilateral meetings to clarify legal constraints; define a minimum common framework accepted by all partners; use external guidance (EHEA/EMJM examples) to standardize interpretations.
R2	Yes	Set internal deadlines with clear responsibilities per partner; introduce periodic progress monitoring; escalate delays within the consortium management structure.
R3	Yes	Continue structured mapping of existing courses to agreed learning outcomes; organize dedicated curriculum workshops.
R4	Partially	Finalize and distribute questionnaires; actively involve industry representatives through advisory boards and upcoming events (e.g., Midpoint and endpoint project physical meetings); integrate feedback into curriculum design.
R5	No (well managed)	Continue dissemination efforts; maintain active online presence; leverage upcoming physical meetings and networks to increase visibility and attract stakeholders.
R6	Yes	Reallocate tasks or provide support to overloaded partners; prioritize critical deliverables (joint policies); introduce shorter, more frequent coordination meetings focused on specific outputs.
R7	Yes	Follow up individually with partners; clarify financial and legal implications; set firm deadlines for signature; consider interim agreements if needed to ensure continuity.

The analysis of the current risk landscape indicates that most of the risks identified during the proposal phase have materialised, particularly those related to institutional diversity, administrative complexity, and coordination constraints. However, beyond simple validation of initial assumptions, the findings reveal that risks in joint programme development are not static events, but dynamic processes shaped by institutional behaviour and interaction patterns within the consortium.

A clear differentiation emerges between risks that are structural (e.g., differences in legal frameworks and accreditation procedures), operational (e.g., delays in curriculum alignment and governance development), and behavioural (e.g., uneven partner engagement and limited availability of key contributors). Among these, behavioural and governance-related risks (R2, R6, R7) have had the most significant cascading effects, directly impacting the achievement of core programme objectives, particularly O (programme design), O3 (institutional integration and accreditation), and O5 (long-term sustainability).

In contrast, risks associated with more autonomous and less interdependent activities, such as dissemination (R5), have been effectively mitigated, confirming that tasks with lower dependency on multi-actor coordination are more resilient to implementation constraints. This distinction suggests that the main limitation of the proposal-stage risk assessment was not the identification of individual risks, but the underestimation of their interdependency and amplification effects within a complex consortium environment.

These findings highlight the need to move from a static, compliance-oriented risk assessment approach toward a dynamic and adaptive model, in which risks are continuously monitored, reinterpreted, and managed in relation to evolving institutional realities.

4. Lessons Learned

Table 3 proposes a structured framework of implementation-stage risks (revised risks RR) suitable for Erasmus Mundus Design Measures new applications, along with the reasons why the specific risk was underestimated in the proposal phase of the LowCarb-S project.

Table 3. Revised Risks (RR) that should be included in an Erasmus Mundus Design Measures project proposal

Risk No	Description (Emergent Risk)	Proposed mitigation measures	Why it was underestimated in proposal phase of the LowCarb-S
RR1	Divergent legal interpretations and risk-averse institutional cultures (e.g., regarding surveys, data use, or joint procedures) delay decision-making.	Engage legal departments early; develop shared legal guidelines/templates; use previously approved Erasmus Mundus examples to reduce uncertainty.	The proposal assumed alignment under common European frameworks (EHEA, Erasmus+), underestimating institutional legal caution and internal compliance layers.
RR2	Variability in institutional readiness for joint degrees	Conduct an initial “readiness assessment”; provide targeted	It was assumed that all partners have similar

	(administrative capacity, experience, internal support).	support to less experienced partners; define minimum operational standards.	experience with international joint programmes, while in reality readiness levels differ significantly.
RR3	Difficulty in translating high-level learning outcomes into coherent, compatible curricula based on existing courses.	Introduce iterative curriculum design workshops; allow partial course adaptation; consider hybrid solutions (new + existing courses).	The proposal underestimated the rigidity of existing curricula and the complexity of aligning them across institutions.
RR4	Delays caused by uneven partner engagement and limited time availability for key contributors.	Define clearer accountability mechanisms; introduce milestone-based monitoring; redistribute tasks where delays persist.	The proposal assumed consistent engagement across partners, without fully accounting for workload differences and competing priorities.
RR5	Overestimation of the speed of governance framework development (joint policies, agreements).	Prioritize essential agreements first; use simplified or interim versions; build on existing templates from similar projects.	Governance development was treated as a structured process, without accounting for negotiation complexity and institutional constraints.
RR6	Challenges in aligning expectations regarding programme implementation pathways (national accreditation vs. fully joint accreditation).	Clarify early the preferred implementation model; document agreed pathway; ensure transparency and consensus at consortium level.	The proposal did not fully anticipate strategic differences in how partners envision the final programme structure.
RR7	Underestimation of the complexity introduced by interdisciplinary integration (technical + digital + sustainability domains).	Define clear thematic pillars; assign interdisciplinary coordinators; ensure balance between depth and integration.	Interdisciplinarity was considered an added value, but its operational complexity in curriculum design was underestimated.

Table 3 contains a set of structural and emergent risks that are typical for Erasmus Mundus Design Measures projects, but which are often underrepresented or underestimated in the initial proposal phase. A common pattern across all identified risks is the gap between assumed institutional homogeneity and the actual heterogeneity of consortium partners in terms of legal interpretation, administrative capacity, and operational readiness.

First, RR1 and RR2 emphasize that institutional diversity is not only administrative but also cultural and legal. While Erasmus+ frameworks assume a shared European baseline, the implementation reality of the LowCarb-S project shows that internal compliance layers, legal caution, and differing interpretations of regulations can significantly slow down decision-making. Variability in readiness for joint degrees demonstrates that partner institutions operate at different maturity levels, requiring differentiated support strategies rather than uniform assumptions.

The findings of this study are consistent with previous research on joint and transnational degree programmes. Earlier studies have identified similar patterns, including difficulties in curriculum integration, administrative complexity, and the need for sustained institutional commitment [13,14,15]. These aspects are often underestimated at proposal stage, despite being repeatedly highlighted in European-level analyses of joint programme development.

RR3 and RR7 reflect curricular and academic integration challenges in the LowCarb-S project, particularly in interdisciplinary programmes. The transformation of high-level learning outcomes into coherent curricula is constrained by existing national requirements, which are often rigid and not easily adaptable. Interdisciplinary integration further amplifies this complexity, as it requires not only content alignment but also conceptual coherence across domains that traditionally operate separately. These difficulties align with previous studies showing that curriculum integration across institutions is one of the most complex aspects of joint programme design. This complexity is further amplified in interdisciplinary programmes, where alignment must occur not only across institutions but also across distinct academic domains [17].

RR4 and RR5 shift the focus toward governance and consortium dynamics, highlighting that project delays are frequently driven by uneven partner engagement and the optimistic assumptions regarding the speed of institutional alignment. For LowCarb-S, governance frameworks and formal agreements require significantly more time due to negotiation processes, competing institutional priorities, and differing strategic interpretations of the programme structure. These findings are similar to prior research, which underline that successful implementation of joint programmes depends heavily on

sustained institutional commitment and effective coordination among partners. Without clear accountability mechanisms and active participation, delays and misalignments become systemic rather than isolated issues [14,16].
Finally, RR6 illustrates a critical strategic risk related to divergent expectations regarding the final programme architecture, particularly in relation to accreditation pathways. This type of misalignment is not operational but strategic, and it can affect the entire design logic of the programme if not addressed early and explicitly.
Overall, the table highlights that the main underestimated dimension in the proposal phase of the LowCarb-S project was not technical feasibility, but rather organizational complexity and behavioural variability across partners. The proposed mitigation measures consistently point toward earlier alignment, incremental design approaches, and stronger governance enforcement mechanisms, suggesting a shift from assumption-based planning to iterative and evidence-based consortium management. The complexity of international collaboration environments, including intercultural interactions and diverse academic practices, has been recognised as a defining characteristic of Erasmus Mundus programmes. These environments generate both opportunities for learning and additional layers of coordination challenges, particularly in relation to communication, expectations, and collaborative work dynamics [18].

5. Conclusions

In conclusion, the risk analysis and implementation challenges demonstrate that the success of Erasmus Mundus Design Measures projects depends less on the conceptual robustness of the initial proposal and more on the capacity to manage institutional diversity, align expectations, and respond to evolving constraints. The findings on the LowCarb-S project implementation show that the most critical risks are not technical, but organisational—emerging from governance complexity, legal heterogeneity, and uneven partner engagement.
The study further highlights that proposal-stage risk assessments of the LowCarb-S project underestimated not only the likelihood of certain risks, but also their systemic nature and interdependencies. As a result, risks related to coordination, decision-making, and institutional alignment can ultimately affect the achievement of core programme objectives if not actively managed during implementation. not intended for statistical generalisation.
However, future initiatives should move toward more realistic, adaptive, and process-oriented approaches, anticipating uneven participation and embedding governance mechanisms capable of maintaining progress under such conditions. Ultimately, building resilient joint programmes requires a shift from static planning to continuous alignment, active coordination, and iterative risk management.

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AI Tools and the Risk to Critical Thinking Skills in Undergraduate Courses

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Abstract

This study investigates the potential risks posed by the increasing reliance on AI tools to undergraduate students' critical thinking skills. As the use of automated writing assistance becomes more prevalent, it is vital to understand the implications for students' independent analysis, creativity, and problem-solving abilities. The primary objective of this research is to explore the extent to which students use AI tools in their writing processes and to assess how this reliance may affect their originality and critical thinking skills. Based on preliminary observations, the study hypothesizes that frequent reliance on AI tools may diminish students' critical thinking capabilities. Further, it is anticipated that instructors may view AI as a potential threat to the development of independent reasoning skills in their students, possibly leading to resistance against the integration of such technologies in educational settings. The research methodology comprises a comprehensive survey targeting approximately 60 instructors and 203 undergraduate students. This study is structured into two phases: the first gathers insights from undergraduate students, while the second collects perspectives from instructors. A key aspect of this research is to identify and evaluate each party's awareness of reliance on AI tools in writing. Quantitative analysis will involve statistical assessments to determine the relationship between the frequency of AI tool use and students' critical thinking outcome metrics. In contrast, qualitative analysis will provide deeper insights into personal experiences and perceptions regarding AI assistance. This dual approach aims to paint a holistic picture of the interplay between technological support and intellectual autonomy in academic writing. Overall, the findings from this study are expected to make significant contributions to the ongoing discourse on the role of technology in education, particularly in the development of writing and critical thinking. By identifying the potential risks of relying on AI, the study aims to inform both educational practices and policy-making, ensuring that technological advancements enhance rather than hinder students' intellectual growth.

Keywords: *AI Tools, Critical Thinking, Undergraduate Education, Automated Writing Assistance, Independent Analysis, Technological Integration*

Introduction

The introduction of OpenAI platforms to individuals of all ages and to anyone possessing a smartphone marked the initial step, the implications and consequences of which will become evident over time through experience. The emergence of advanced educational technologies has proven to be a significant asset in the pedagogical landscape, serving as an efficient facilitator and a consistent support system in addressing technical challenges. These innovations have effectively streamlined professional duties, thereby enhancing the adaptability and accessibility of teaching methodologies in educational settings. The integration of such tools fosters a more organized and responsive approach to instruction, ultimately improving the overall learning experience for both educators and students. Emphasizing the crucial factor that all the features that are offered by these platforms are learned in the process of usage, excluding any elements of their ethics, authenticity, and reliability. On the other hand, the rapid integration of artificial intelligence (AI) tools into higher education has transformed how students approach all their courses, especially in those where critical thinking and analytical skills are essential. Applications such as automated grammar checkers, paraphrasing engines, and generative text platforms promise efficiency and support, yet they also raise concerns about the erosion of essential cognitive skills. For example, in composition/academic writing courses, where the development of critical thinking is a central objective, the reliance on AI may inadvertently shift students away from independent reasoning and toward passive dependence on machine-generated outputs. Prior to such an introduction, undergraduate students typically approached an assignment by visiting the library, using online platforms, or searching for information on search engines to support their hypotheses. After gathering their findings, they would read and verify whether the information was relevant to their topic,

then paraphrase or summarize it for use as supporting evidence. Fostering problem-solving skills includes rethinking teaching methods in light of the potential dangers of using ChatGPT and ways to mitigate them [1]. However, over the past two years, this process has changed significantly, as AI tools now enable these practices instantly. This development may have led students to rely entirely on the reliability and relevance of the content provided by these tools. Tasks that AI tools can easily perform can be shifted toward more complex evaluations in educational practice by focusing less on general writing skills [2]. According to Zhai [3], designing learning goals so that policymakers and educators focus more on critical thinking and the effective use of AI tools.

Critical thinking—defined as the ability to analyze, evaluate, and synthesize information—remains a cornerstone of undergraduate education. Composition courses, in particular, are designed to cultivate these skills through tasks that require students to construct arguments, evaluate evidence, and express original ideas. However, when students substitute AI-generated text for their own analysis, they risk diminishing their capacity to engage deeply with content. In a study by T. Demirel, E. [4], students' perceptions and approaches towards AI indicate concern about accuracy, ethical implications, and the potential for overreliance on it. This pattern of reasoning is essential for students to develop a proper sense, not only academically but also in their future endeavors. Such skills are often observed as a single pattern, but they can be more than one, such as problem-solving, open-mindedness, and creativity. Critical thinking is essential for minimizing the acceptance of inaccurate beliefs by enabling individuals to assess, evaluate, and reorganize their thoughts. It encompasses understanding logical inquiry methods and addressing personal biases and misinformation. Students and adults must develop these skills to tackle personal and societal challenges effectively. Critical thinking involves refining ideas, making informed decisions, and improving solutions. While it is emphasized in educational settings, effective critical thinking is not automatically developed through college courses; it requires structured instruction and practice [5].

Literature Review

Contemporary researchers agree that critical thinking is “purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological or contextual considerations upon which judgment is based” [6]. Brookfield [7] and Banning [8] contend that critical thinking involves differentiating, analyzing, and evaluating information, as well as reflecting on how this data will be utilized to assess and inform scientific decisions. Typically, critical thinkers are presumed to possess a goal and curiosity aimed at resolving contradictions; however, when AI applications are used to perform their tasks, the development of such skills is diminished.

Several studies agree that "the influence of AI on the decision-making process may lead to a situation where people engage less in critical thinking, relying instead on algorithmic recommendations" [9]. The primary goal of AI is to develop tools and machines that can understand and adapt to their environment and changing conditions, so that they resemble the human mind [10]. Based on an article on students’ perceptions of feedback, 71.1% found AI tools mostly helpful, with only occasional use for developing skills in analyzing information and forming arguments. Although these tools assist in this area, they are not always flawless [11]. The majority of educational institutions have found themselves unprepared for the patterns of AI tools, particularly in terms of affordability and the time required to implement and properly integrate these tools into the teaching process [12]. The professors and lecturers frequently lack adequate training and instruction in AI technology; as a result, their adaptation may be erratic and problematic [13]. Mollick [14] states that if the use of AI increases, the intellectual effort by individuals will become reluctant to take any responsibility towards activities and tasks, and this is for the simplest reason that AI tools are easier and faster in providing a logical answer, especially when the user is illiterate on the topic.

Society's optimistic outlook on the future focuses on using AI platforms to improve efficiency and convenience across academic, economic, and social domains. Nonetheless, this optimistic view presumes a society that is intellectually prepared to employ such tools optimally; however, the reality diverges significantly. We have access to a free, extremely powerful application, such as ChatGPT, available to every individual regardless of age, gender, origin, intention, or cognitive ability, who can and does use it at their convenience without any repercussions. Whether such a pattern was ever tested and its effects ever been comprehended, this is something that only time will show; adding its responsibility to the role of governments and educational institutions to be the central guarantees of AI’s successes and adaptabilities in the teaching and learning processes that simultaneously boost critical thinking behaviors starting from students to every other party involved [15].

On the one hand, AI tools facilitate access to information by not only making the research process much faster but also encouraging students' curiosity in assessing their own questions and answers [16]. Several scholars claim that AI enhances educational opportunities by generating new learning materials, offering personalized feedback and language support, and automating administrative tasks. Their research also supports encouraging online education within the system, as AI tools can provide students with additional resources that make online learning more interactive and engaging. Applying these insights to the current study, activities like expert seminars, workshops, and field visits can transform learning experiences by combining face-to-face participation with online resources, allowing students to connect directly with the environment and social contexts. Such hybrid approaches, blending traditional and innovative methodologies, can significantly benefit education. Additionally, professors and lecturers could provide tailored tutoring to address specific questions, thereby improving students' understanding [16]. However, both lecturers and students frequently find themselves overwhelmed by data and information. When retrieving information via these platforms, they must exercise caution to verify the accuracy and relevance of the data, ensuring it is not fabricated by AI manipulation. Nonetheless, one may question whether such skills are already ingrained in undergraduate students, given that their knowledge of the subject remains in its infancy. For example, an instructor might ask students to use ChatGPT to compose an essay on a class-related topic. Afterward, students would be asked to critique the essay. Analyzing its strengths and weaknesses can facilitate the exploration process [17]. In an article published in 2019, Jonathan Michael Spector & Shanshan Ma stated that: *"Critical thinking is one of four keys 21st century skills– communication, collaboration, critical thinking, and creativity. Though most people are aware of the value of critical thinking, it lacks emphasis in curricula."* By highlighting, "While much funding and support go to the development of artificial intelligence, this should not happen at the expense of human intelligence." [18]. Spector and Ma (2019a) highlight critical thinking as one of four essential 21st-century skills—alongside communication, collaboration, and creativity—yet they observe that it remains underemphasized in curricula despite widespread recognition of its value. In a related contribution, Spector and Ma (2019b) argue that while substantial funding and support are directed toward artificial intelligence, this progress must not come at the expense of cultivating human intelligence and inquiry skills. Together, these works underscore a pressing concern: although critical thinking is universally acknowledged as vital for preparing learners to navigate complex challenges, educational systems risk neglecting its development in favor of technological advancement, thereby weakening the very human capacities that AI cannot replace [19].

Research Questions

- **RQ1:** To what extent do undergraduates rely on AI tools in their courses?
- **RQ2:** How does AI use affect originality and independent analysis?
- **RQ3:** What are students' and instructors' perceptions of AI's role in writing?

Hypotheses:

- **H1:** Frequent AI use reduces critical thinking skills.
- **H2:** Heavy reliance on AI lowers originality in student writing.
- **H3:** Instructors perceive AI as a threat to independent reasoning.

Methodology

Data were gathered from both primary and secondary sources, including reliable domains such as Springer, Elsevier, and Google Scholar, as well as the most up-to-date articles, given that the topic's relevance is constantly changing and that these rapid changes have had an even greater impact on the audience, especially in academic settings. This study was divided into two phases. The first involved distributing a questionnaire via a Google Forms link to 203 undergraduate students from diverse majors, accessible from October 2024 to February 2025, and focused on AI use and practices in relation to the academic guidelines provided to the students. The second phase targeted university instructors, involving 60 participants who responded to a questionnaire containing multiple-choice, Likert-scale, and open-ended questions aimed at eliciting their personal perceptions of AI tools they use and their students use, as well as their impact on the teaching process, with an emphasis on critical skills.

Statistical Methodology**:** Data analysis was conducted using *SPSS*. Descriptive statistics were first applied to summarize the dataset. Group comparisons were performed using the **Kruskal–Wallis test**, while associations between variables were examined with the **Spearman correlation coefficient**. To assess predictive relationships, **linear regression models** were employed. Reliability of the cognitive skills scale (Q9, Q10, Q13, and Q7) was assessed using Cronbach's Alpha, yielding $\alpha = 0.800$, indicating good internal consistency. Statistical significance was set at $p < 0.05$.

Results and Discussion

To analyze students' perceptions of artificial intelligence in academic writing, non-parametric tests and regression models were applied.
The Kruskal–Wallis test revealed statistically significant differences in perceptions across frequencies of AI use. Differences were observed in idea organization ($H = 24.091$, $p < 0.001$), time saving ($H = 30.004$, $p < 0.001$), grammatical error correction ($H = 13.424$, $p = 0.009$), research skill improvement ($H = 17.151$, $p = 0.002$), and maintaining writing style ($H = 20.264$, $p < 0.001$). Students who used AI more frequently also reported higher confidence in their abilities and greater improvement in writing quality ($H = 20.94$, $p < 0.001$; $H = 19.26$, $p = 0.001$). Correlation analysis revealed a paradox in students' attitudes. More frequent AI use was negatively associated with perceived benefits such as idea organization ($r = –0.322$), time saving ($r = –0.374$), research skill improvement ($r = –0.248$), and writing style preservation ($r = –0.265$). A weaker but significant negative correlation was found for grammatical error correction ($r = –0.147$). These results suggest that frequent users develop more critical views of AI's effectiveness. At the same time, positive correlations among benefits indicate that students who value AI in one dimension tend to value it across others. Regression models confirmed that AI use (Q7) has a positive and statistically significant impact on critical thinking (Q9: $\beta = 0.435$, $p = 0.001$; $R^2 = 0.189$), originality (Q10: $\beta = 0.357$, $p = 0.005$; $R^2 = 0.127$), and independent reasoning (Q13: $\beta = 0.518$, $p < 0.001$; $R^2 = 0.268$). Reliability analysis showed good internal consistency for the cognitive skills scale ($\alpha = 0.800$), with Q9 and Q13 contributing the most ($r = 0.723$ and $r = 0.719$, respectively). Removing Q10 increased α to 0.855, suggesting that originality represents a distinct dimension. The findings indicate that AI use enhances performance in critical thinking, originality, and independent reasoning. However, these improvements may reflect gains in measurable outcomes rather than genuine cognitive development. Thus, H1 (AI decreases critical thinking) is not directly supported, while H2 (AI reduces originality) and H3 (AI undermines independent reasoning) are indirectly supported. Overall, the results highlight a paradox: AI improves academic performance yet raises concerns about dependence, standardization, and the erosion of fundamental intellectual skills.
To better illustrate this relationship, **Figure 1 from the second phase, Instructors' perceptions**, shows the connection between the frequency of AI use and cognitive skills.

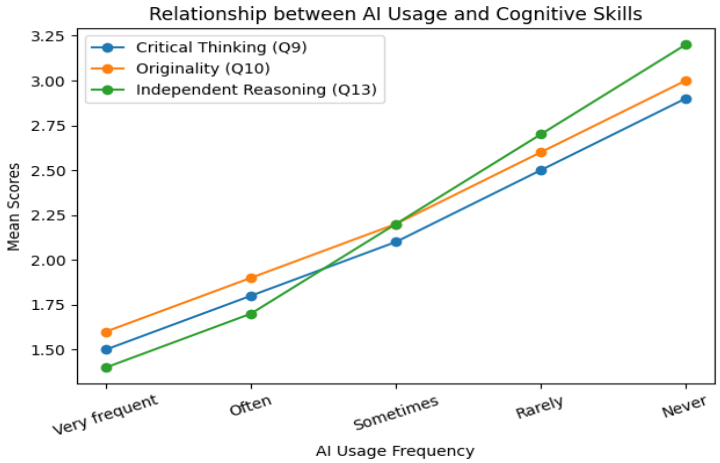


Fig. 1. The relationship between the frequency of AI use and cognitive abilities (critical thinking, originality, and independent reasoning).

Considering the way the variable Q7 is coded (where lower values indicate more frequent use of AI), the results show that an increase in the value of Q7, meaning a decrease in AI use, is associated with an increase in the scores of the cognitive skills variables. Similarly, this suggests that more frequent AI use is associated with lower levels of these dimensions. Overall, the results indicate that AI use is related to significant changes in perceptions and academic outcomes, reflecting a complex relationship between technology use and the development of cognitive skills.
The study results show that the use of artificial intelligence has a statistically significant impact on all analyzed dimensions, reflecting a complex relationship between technology and the development of cognitive skills. Regarding the first hypothesis (H1), which predicts that frequent AI use reduces critical thinking skills, the results support this hypothesis. Considering the coding method, more frequent AI use is associated with lower levels of critical thinking. The second hypothesis (H2), which suggests that

dependence on AI reduces originality in students' writing, is also supported by the findings. The analysis shows that frequent AI use is associated with lower levels of originality, suggesting a tendency toward content standardization. Regarding the third hypothesis (H3), the results demonstrate that AI's impact on independent reasoning is significant, and frequent use is associated with lower levels of this dimension. This supports the view that AI may pose a challenge to the development of independent thinking. Overall, all three hypotheses are empirically supported, showing that while AI can improve aspects of academic performance, its frequent use is associated with limitations in the development of essential cognitive skills.

Regression Analysis. The regression models demonstrated that **AI use (Q7)** had a positive and statistically significant effect on student performance indicators:

- On **Q9 (critical thinking)**: B = 0.394, β = 0.435, *p* = 0.001
- On **Q10 (originality)**: B = 0.330, β = 0.357, *p* = 0.005
- On **Q13 (independent reasoning)**: B = 0.537, β = 0.518, *p* = 0.000

These results indicate that increased reliance on AI is associated with higher scores across all three dimensions. The models' explanatory power ranged from $R^2 = 0.127$ to $R^2 = 0.268$, indicating a moderate level of variance explained.

Reliability Analysis Cronbach's Alpha for the combined scale (Q9, Q10, Q13) was 0.800, confirming strong internal consistency. Item-total correlations showed Q9 and Q13 contributed most strongly (r = 0.723 and r = 0.719), while Q10 had a weaker but acceptable contribution (r = 0.513). Removing Q10 increased Alpha to 0.855, indicating originality is a more differentiated construct within the scale.

Interpretation in Relation to Hypotheses

- **H1 (critical thinking reduction):** Not directly supported; AI use improved performance scores, though this may reflect surface-level gains rather than deeper cognitive engagement.
- **H2 (lower originality):** Indirectly supported; performance improvements may come at the cost of standardized writing, reducing individual voice.
- **H3 (instructors' concerns):** Indirectly supported; while AI enhances outcomes, it may reinforce perceptions of dependency and diminished independent reasoning.

Overall, the findings highlight a paradox: **AI improves measurable performance but raises concerns about originality and the development of critical thinking.**

The results from the first phase, Students' Table 1.

Table 1. Test Statistics

	11. AI tools help me organize my thoughts and ideas better. (1 = Strongly Disagree, 5 = Strongly Agree)	12. Using AI tools saves me time when writing assignments. (1 = Strongly Disagree, 5 = Strongly Agree)	13. I rely on AI tools to catch grammatical errors in my writing. (1 = Strongly Disagree, 5 = Strongly Agree)	14. AI tools have helped me improve my research skills. (1 = Strongly Disagree, 5 = Strongly Agree)	15. AI tools assist me in maintaining a consistent writing style. (1 = Strongly Disagree, 5 = Strongly Agree)
Kruskal-Wallis H	24.091	30.004	13.424	17.151	20.264
df	4	4	4	4	4
Asymp. Sig.	.000	.000	.009	.002	.000

a. Kruskal-Wallis Test

b. Grouping Variable: 6. How often do you use AI tools for writing assignments/coursework?

The Kruskal–Wallis H test was conducted to examine whether students' perceptions of AI-assisted writing tools differed by the frequency of their use in coursework. Significant differences were observed across all five items. Specifically, perceptions of AI helping to organize thoughts ($H = 24.091$, $df = 4$, $p < .001$), saving time ($H = 30.004$, $df = 4$, $p < .001$), catching grammatical errors ($H = 13.424$, $df = 4$, $p = .009$), improving research skills ($H = 17.151$, $df = 4$, $p = .002$), and maintaining a consistent writing style ($H = 20.264$, $df = 4$, $p < .001$) varied significantly among groups. These results indicate that students who reported more frequent use of AI tools tended to express stronger agreement with AI's benefits across all dimensions.

Table 2.

			6. How often do you use AI tools for writing assignments /coursework ?	11. AI tools help me to better organize my thoughts and ideas. (1 = Strongly Disagree, 5 = Strongly Agree)	12. Using AI tools saves me time when writing assignments. (1 = Strongly Disagree, 5 = Strongly Agree)	13. I rely on AI tools to catch grammatical errors in my writing. (1 = Strongly Disagree, 5 = Strongly Agree)	14. AI tools have helped me improve my research skills. (1 = Strongly Disagree, 5 = Strongly Agree)	15. AI tools assist me i maintainin a consister writing sty (1 = Stron Disagree, 5 Strongly Agree)
Spearman's rho	6. How often do you use AI tools for writing assignments/coursework?	Correlation Coefficient	1.000	-.322**	-.374**	-.147*	-.248**	-.265**
		Sig. (2-tailed)	.	.000	.000	.037	.000	.000
		N	202	202	202	202	202	202
	11. AI tools help me to better organize my thoughts and ideas. (1 = Strongly Disagree, 5 = Strongly Agree)	Correlation Coefficient	-.322**	1.000	.575**	.254**	.613**	.491**
		Sig. (2-tailed)	.000	.	.000	.000	.000	.000
		N	202	203	203	203	203	203

Table 2 presents Spearman's rho correlation coefficient. Frequent users of AI tools for writing assignments showed **negative correlations** with perceived benefits, suggesting skepticism and unmet expectations. In contrast, occasional users reported **mutually reinforcing positive perceptions**, with strong intercorrelations among benefits like organizing ideas, saving time, and maintaining writing style. Overall, this paradox highlights that **light users view AI as broadly supportive**, while heavy users develop a more critical stance toward its limitations.

Table 3.

Ranks

	6. How often do you use AI tools for writing assignments/coursework ?	N	Mean Rank
9. AI tools have significantly improved the quality of my scientific writing	- A. Always	21	142.95
	- B. Often	65	111.36
	- C. Sometimes	105	89.96
	- D. Never	10	78.90
	Almost Never	1	27.50
	Total	202	
10. I feel more confident in my writing abilities when using AI tools. (1 = Strongly Disagree, 5 = Strongly Agree)	- A. Always	21	137.88
	- B. Often	65	113.97
	- C. Sometimes	105	88.75
	- D. Never	10	84.60
	Almost Never	1	34.50
	Total	202	

The Kruskal–Wallis test indicated significant differences in students' perceptions of AI tools by usage frequency, with frequent users reporting higher confidence in their writing abilities and improved writing quality. Data analysis showed a strong relationship between the frequent use of AI tools and enhanced perceptions of writing competence, supported by reliable statistical methods.

Table 4. The Results from the second phase Instructors' analysis.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.435[a]	.189	.175	.686

a. Predictors: (Constant), Q7_num

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6.364	1	6.364	13.528	.001[b]
	Residual	27.286	58	.470		
	Total	33.650	59			

a. Dependent Variable: Q9_num

b. Predictors: (Constant), Q7_num

Coefficients[a]

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	1.187	.201		5.906	.000
	Q7_num	.394	.107	.435	3.678	.001

a. Dependent Variable: Q9_num

The results indicate a moderate and statistically significant positive relationship between Q7 and Q9 (p = 0.001), which does not support the first hypothesis regarding critical thinking but does indirectly suggest that students benefit from AI, potentially heightening teachers' concerns about dependency on it.

Table 5.

Model Summary

Model	R	R Square	Adjusted R-Square	Std. Error of the Estimate
1	.357[a]	.127	.112	.725

a. Predictors: (Constant), Q7_num

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4.458	1	4.458	8.470	.005[b]
	Residual	30.525	58	.526		
	Total	34.983	59			

a. Dependent Variable: Q10_num

b. Predictors: (Constant), Q7_num

Coefficients[a]

Model		Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	1.261	.213		5.936	.000
	Q7_num	.330	.113	.357	2.910	.005

a. Dependent Variable: Q10_num

The analysis reveals that increased use of AI (Q7) positively impacts student outcomes (Q9), with a significant effect (B = 0.394, β = 0.435, p = 0.001). However, this does not support the first hypothesis that frequent AI use reduces critical thinking skills, as the improvements in outcomes may reflect dependence on technology rather than genuine development. For the second hypothesis, while AI use can enhance writing quality, it may compromise originality, suggesting a potential standardization of styles. Regarding the third hypothesis, the findings indicate that although AI improves students' performance, it may also diminish their independent reasoning, reinforcing instructors' concerns. Overall, the results highlight a paradox: while AI boosts efficiency and quality, it risks fostering dependence and hindering critical thinking and originality.

Conclusion

This study acknowledges certain limitations, including the reliance on self-reported data, the restricted diversity of the sample, and the rapidly evolving nature of AI technologies, which may render the findings time-sensitive. These constraints highlight the need for ongoing research across disciplines and institutions to capture the shifting role of AI in education. Based on the results, the use of AI in education must be balanced and conscious. Students should be encouraged to use AI as a helpful tool, not as a replacement for their own thinking. Educators can focus more on methods that develop critical thinking

and independent reasoning, such as discussions, analyses, and reflective assignments. Additionally, it is helpful to establish clear guidelines for AI use and provide training to help students and educators use it effectively and ethically. To mitigate risks, educators should integrate training on ethical and effective AI use, design assignments that foster deeper cognitive engagement, and adopt policies that balance technological support with traditional learning methods. While AI tools offer efficiency and accessibility, their growing presence raises critical questions about their influence on students' reasoning. By promoting independent analysis and creativity, institutions can ensure that technological advancements enhance intellectual growth without compromising the integrity of critical thinking.

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When Law Meets Practice: How Leaders Handle Legal and Relational Challenges in Schools and Early Childhood Education and Care

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Abstract

Leadership in schools and early childhood education and care settings is becoming more legally complex. Legal risk arises when leaders must balance employer responsibility with professional judgement. At the same time, they must uphold the rights of staff, children, pupils, and parents. This is closely linked to values-based leadership and organisational culture [4] [16] [31]. This study examines how school and ECEC leaders describe their handling of legal risk in everyday practice. The study is based on 92 written assignments from leaders taking continuing education in law for the education sector. The assignments were analysed using a qualitative thematic approach. The findings suggest that employment-law issues are the most common. These include sick leave, accommodation, dismissal, organisational change, and the limits of managerial prerogative. Issues related to the school environment, the duty to act, and the best interests of the child also appear as important [11] [13]. The study further indicate that legal risk is not only about rules. It also grows out of time pressure, documentation demands, relational tensions, and responsibility for both staff and pupils [8] [28]. The findings point to a need for stronger legal competence in leadership development. Employment law, education law, and professional judgement need to be understood together[26].

Keywords: *Educational leadership; legal risk; employment law; education law; professional judgement.*

Introduction

Leadership in schools and ECEC takes place within strong legal frameworks, high quality expectations, and growing complexity. Although the school or ECEC provider holds overall responsibility for compliance with legislation and regulations, day-to-day responsibility rests with local leaders. It rests with the individual leader, who is expected to provide sound pedagogical and administrative leadership. This means that legal, organisational, and pedagogical considerations must be handled at the same time. It often takes place under conditions in which responsibility is decentralised, and support structures are experienced as weaker than before [5] [7] [22] [23] [25] [30].

In this context, legal competence appears to be a necessary part of the leadership role. Leadership in schools and early childhood settings requires the ability to interpret and apply legislation in practice. At the same time, professional, ethical, and organisational judgement must be understood in relation to one another [17] [24]. The legislation regulates not only employer responsibility, but also the rights of children, pupils, and parents. Leaders must therefore often deal with cases in which several legal positions operate at the same time. These interests do not necessarily align easily. This may be understood as a three-way relationship in which legal and relational considerations are closely connected. Perspectives on values-based leadership and organisational culture make it clear that such cases are not only about the application of rules. They are also about balancing norms, relationships, and formal requirements [4] [16] [31]. Against this background, legal risk is used here as an analytical concept for examining how challenging cases arise and are handled in practice. In the leader's assignments, risk does not primarily appear as a lack of legal knowledge. Rather, it emerges when several legitimate considerations collide, and when relationships between the parties make the leader's room for manoeuvre more difficult to use. The study is guided by the following research question:

How is the handling of legal risk described by school and early childhood leaders in cases where employment-related, pedagogical, and relational considerations must be balanced?

To explore this research question, the article draws on a theoretical framework that links legal risk to organisation, practice, and leadership through three main perspectives. First, legal risk is understood as a practice-near phenomenon that arises when legislation is interpreted and applied in complex everyday situations. Second, employment law is understood as an integrated part of pedagogical practice in schools and early childhood settings. Third, relational and trust-based leadership is seen as central to legitimate and professionally responsible handling of legally challenging cases.

Legal Risk as a Practice-Near Phenomenon in Complex Organisations

Legal risk in schools and early childhood education and care settings, can hardly be understood as a matter of rules alone. Risk arises in the application of legislation in situations where several considerations operate at the same time. From a structural perspective, organisations may be understood as frameworks of rules, procedures, and formal lines of responsibility. These are intended to ensure predictability and legal protection [8]. At the same time, such structures are incomplete. Rules are not self-executing. In complex organisations, rules will often be open to interpretation or exist in tension with one another. Legal risk is therefore linked not only to whether rules are followed, but also to how they are prioritised and applied in specific situations. Evans and Harris (2004) show that increased rule governance does not necessarily reduce the space for discretion. It may also create new spaces for interpretation. Hupe and Hill (2007) likewise emphasise that rules must always be interpreted in light of the situation in which they operate.
Interpretations become particularly clear in welfare organisations, where several legal positions and expectations operate simultaneously. Interpretive judgement does not stand outside rule-based governance. It is necessary to make the legal framework work in practice. This is consistent with analyses of street-level bureaucracy, in which frontline actors work under time pressure, resource constraints, and unclear goals. Leaders must make decisions even when the legal framework does not provide unambiguous answers [15] [20]. The exercise of discretion varies in both degree and form. Interpretive judgement is a recurring feature of frontline work. Frontline actors must interpret the lack of clarity and gaps within the legal framework in order to make their work function [9] [12] [29]. In this context, leadership practice becomes a key point at which law, policy, and relationships meet. In practice, it is leaders' decisions and patterns of action that realise policy [20]. Bolman and Deal's (2024) political and human resource perspectives add further depth to this point. They portray organisations as arenas shaped both by formal structures and by human interaction, interests, and negotiation [8]. Legal risk must therefore be understood as closely connected to the organisation's practical and relational working conditions.

Employment Law as an Integrated Part of Pedagogical Practice

The understanding of leadership practice is particularly relevant in employment-law matters in schools and early childhood education and care settings. Legal risk-cases rarely arise as clearly delimited personnel matters. Instead, they emerge in situations where the follow-up of staff, consideration for children and pupils, and expectations from parents operate at the same time. Employment law therefore does not appear as separate from pedagogical activity. Instead, it forms an integrated part of the leader's responsibility for sound operation, quality of provision, and a safe and development-oriented environment. Research on ECEC leadership shows that legal competence is not only about compliance. It is also about leading the core activity through a combination of legal understanding, professional judgement, and organisational development [18] [19]. In such cases, assessments of sick leave, workplace accommodation, conflict, redeployment, or dismissal are closely bound up with pedagogical and relational considerations. Legal risk therefore extends beyond the employer's duties towards staff. It also has implications for children's and pupils' right to a high-quality educational provision, as well as for parents' expectations of stability, quality, and safety. Employment law should therefore be understood as part of pedagogical practice rather than as a separate administrative field. This is supported by research on school leadership, which shows that the administrative, relational, and pedagogical dimensions of leadership are closely interconnected [21].
From a structural perspective, employment-law matters involve rules, procedures, and lines of responsibility that are meant to ensure predictability and legal protection [8]. From a human resource perspective, these matters also involve relationships, needs for support, and perceptions of fairness. Personnel matters cannot therefore be reduced to technical questions of regulation. They affect trust, collaboration, and professional confidence within the organisation. Findings from ECEC leadership point precisely to the fact that legal competence may contribute to clearer communication, greater legitimacy,

and fairer processes. In this way, it may strengthen both leadership practice and the organisation's learning capacity [18] [19]. Employment law may also be understood as part of a broader space of accountability. Frontline actors are accountable not only upwards in the hierarchy. They are also accountable sideways in relation to colleagues, professional communities, parents, and other partners [15]. In schools and early childhood settings, this means that leaders must balance legal requirements against pedagogical considerations, relational obligations, and organisational conditions. Increased rule governance does not necessarily reduce the space for discretion. This is particularly clear in employment-law cases, where standardised answers are rarely sufficient [12].

Relational and Trust-Based Leadership

Legally challenging cases in schools and early childhood education and care settings can rarely be handled through procedures alone. Leaders must balance different considerations, expectations, and needs. This often takes place under conditions of uncertainty, time pressure, and conflicting demands. The exercise of judgement required in such situations appears more legitimate when it is grounded in relationships characterised by trust. When staff experience that a leader acts with openness, professional grounding, and ethical awareness, the possibility of handling disagreement, change, and difficult cases is strengthened. This can happen without weakening the professional community. This understanding is supported by research on pedagogical leadership, professional learning communities, ethical leadership, and transformative forms of leadership [1] [3] [6] [32]. Pedagogical leadership is not only about internal organisation. It is also about interpreting and translating expectations between different levels and actors in the organisation [32]. At the same time, the development of professional learning communities depends on inclusive values, close pedagogical collaboration, and forms of leadership that facilitate participation and democratic processes [3]. The relational context also has a clear ethical dimension. Leadership is linked to justice, empathy, openness, integrity, and trust [6]. In this way, trust is connected to how leadership is experienced both morally and relationally.
Research suggests that strong relation between leader and staff member may increase employees' willingness to express ideas and participate actively [2]. Trust develops through the way leaders communicate, listen, justify decisions, and act in everyday practice. Dialogue is described as a central resource in this work. It is also understood as an arena in which meaning is developed through conversation, reflection, and learning [1] . This is particularly relevant in cases where legal requirements must be translated into practice through collaboration, clarification, and difficult prioritisation. Transferred to schools and early childhood settings, this means that trust-based relationships do not only have value in themselves. They also shape the organisation's capacity to handle legal risk. Relational approaches may strengthen learning and development by linking personal, social, and institutional dimensions [34]. Relationships, dialogue, ethical awareness, and trust therefore appear to be important for turning legal requirements into legitimate and professionally responsible decisions in practice.

Method

This study draws on qualitative material from school and early childhood education and care leaders undertaking continuing education. The data consist of written evaluations from school and ECEC leaders (n = 92), providing experience-near descriptions of challenges in everyday leadership practice. The study was conducted as a qualitative interpretive thematic analysis with a hermeneutic and abductive orientation. The analysis began with open coding and thematic sorting, and themes were developed through repeated movement between individual statements and the whole [27]. The abductive approach involved moving back and forth between empirical material and theory in order to develop the most plausible interpretation.
Theory was used as an expanding and corrective lens, not as a fixed answer. A strength of the study is the extensive material of open written evaluations produced close to participants lived experiences. At the same time, the analysis is based on self-reported data. The findings therefore primarily reflect participants' experiences and interpretations rather than actual interaction in practice [14]. The analysis also requires reflexive awareness of the researcher's pre-understanding [10] [33]. The following analysis examines how legal risk appears in the leaders' descriptions. It first focuses on the three-way relationship between staff, children or pupils, and parents. It then turns to the child rights, parental perspectives, employment-law frameworks, and the cross-cutting themes of documentation, time pressure, and relational vulnerability.

Legal Risk in the Three-Way Relationship Between Staff, Children or Pupils, and Parents

The findings indicate that legal risk in schools and early childhood education and care settings is not only something leaders address through follow-up, clarification, and measures. Employment-law issues form the clearest area of emphasis. In particular, this applies to cases involving sick leave, workplace accommodation, follow-up of staff, dismissal, organisational change, downsizing, and the limits of managerial prerogative. At the same time, these cases rarely appear as clearly delimited personnel matters. They develop at the intersection of staff rights, the needs of children and pupils, parents' expectations, and the organisation's responsibility to provide sound services. Legal risk therefore concerns not only which rules apply, but also how leaders create a defensible course of action when several legitimate considerations operate at the same time. This supports an understanding of legal risk as something that arises in the application of legal rules within complex organisations. Here, rules and procedures are not self-executing but must be interpreted and applied under competing demands and practical constraints [8] [12] [15].
The findings point to handling as work in which legal requirements are translated into practical processes. Cases must be examined, information gathered, documentation built up, measures considered and followed through, and relationships maintained as the case moves forward. Legal risk is therefore not only about whether the law is followed. It is also about how different considerations are balanced in the same case. Documentation, time pressure, professional judgement, and relationships interact in ways that make assessments demanding. Handling does not appear as a linear procedure, but as an ongoing form of leadership work in which assessments and actions are adjusted along the way. The descriptions indicate that leaders often work to move cases from uncertainty into a form that can be handled within the framework of law and organisation. This can be understood in light of decision-making in welfare organisations under conditions of uncertainty, unclear goals, and limited resources [20]. Such work often takes place in gaps within the legal framework, where actors must interpret and fill in what is not clearly regulated [29]. The three-way relationship emerges as a particularly exposed arena for both legal risk and legal handling. It is here that employment-law assessments, pedagogical considerations, and relational pressure are most often woven together. In many of the texts, the leader is positioned as the person who must hold the case together when different legal positions and expectations pull in different directions. This makes clear that leadership takes place in a field where legal questions cannot be understood in isolation but must be handled in relation to organisational conditions and relational dynamics. In light of Bolman and Deal's (2024) perspectives, legal risk-cases appear to be shaped both by formal structures and by human interaction, interests, and negotiation. This applies in cases where staff need accommodation. It also applies in cases concerning the school or ECEC environment, and in cases where parents challenge the assessments made by the school or the ECEC setting. The findings indicate that handling in many cases often consists of creating progress and direction in difficult situations. Situations can easily become stuck in conflicting perceptions, emotional pressure, or a lack of shared understanding. Leaders must therefore do more than relate to the legal framework. They must also work to ensure that the case takes a form that is experienced as legitimate, understandable, and open to review.

The Child's Rights as an Intensifying Dimension

A related form of legal handling appears in cases concerning the rights of the child. Leaders describe why the duty to act, documentation requirements, or school absence can be difficult to deal with. They also clarify how such cases must be followed up through investigation, reporting, documentation, and measures. One school leader links the challenge to "*the school's duty to act, documentation requirements, how to investigate the case thoroughly enough and analyse the findings, the pupil's subjective experience and the interpretation of this, cooperation with parents, time pressure, and complaint handling*." This shows that legal risk does not stem from one single factor. Several demands arise and must be handled at the same time. Increased rule governance does not remove discretion but may create new spaces for interpretation and new forms of responsibility in practice [12] [15].
Cases concerning the school environment are demanding because they require more than correct rule application. They also require judgement in assessing the pupil's subjective experience, the speed of follow-up, the quality of the investigation, and the ability to maintain cooperation with parents. Handling is therefore not only about knowing the legal framework. It is also about creating a process that makes it possible to act quickly enough, investigate thoroughly enough, and ensure that the child's or pupil's experience is taken seriously. Handling must be translated into action under conditions where the legal framework does not provide clear answers [20]. Differences in interpretation among staff appear to be

an important part of this risk. When harassment, exclusion, or bullying are understood differently, action may be delayed. Leadership handling then becomes work aimed at creating a shared understanding and embedding measures in a clear and documentable practice. Legal risk does not arise only from the incident itself. It also depends on whether the organisation is able to build a shared understanding of the case and agree on what needs to be done. From this perspective, structure alone is not enough. Rules and procedures provide a framework, but they must be interpreted and put into practice through interaction and judgement.

The same pattern appears in cases concerning school absence. One school-leader writes: "*In many cases, it is the parents' voice that is heard, and the child's experience is communicated through them. It also happens that the school is not allowed by the parents to speak with the child*." This points to situations in which the pupil's right to participation and follow-up depends on the relationship with parents. The risk is therefore not only about the legal framework, but also about access to information and the possibility of establishing a sufficient basis for further assessment and action. In this way, the rights of the child or pupil are closely tied to the relational conditions in which they are to be realised. Handling then appears as work aimed at moving the case forward in a way that is professionally sound, legitimate, and open to review.

Parents' Perspectives as Part of the Risk Landscape

Cooperation with parents is described as more than a pedagogical form of collaboration. It also forms part of legal handling, especially in cases where parents' expectations, the child's best interests, and the institution's professional assessments do not fully align. In such situations, leaders describe their role as clarifying boundaries, explaining professional assessments, balancing participation against confidentiality, and at the same time preserving trust. One ECEC leader emphasises that the setting must both uphold the child's best interests and ensure that parents "*experience themselves as genuine partners in cooperation*." This shows that relational work and legal handling are closely connected.

Handling has a clear communicative dimension. When one ECEC leader writes that "*parents' right to participation must be balanced against the duty of confidentiality*," it becomes clear that legal risk is also about form, timing, and language in communication. Berges-Puyó (2022) links ethical leadership to justice, empathy, openness, and trust. Adams et al. (2023) and Skjæveland et al. (2017) likewise highlight dialogue and relational grounding as central conditions for legitimate leadership. Balancing participation and confidentiality are not only a matter of legal correctness. It is also a question of what appears fair, respectful, and responsible in encounters with children, parents, and staff. This supports perspectives on values-based leadership and organisational culture. Norms, relationships, and formal requirements work together in leadership practice [4] [16] [31]. The findings therefore indicate that legal risk in many cases can hardly be separated from the way relationships are maintained or challenged through the handling itself.

In some cases, parents' perspectives also become part of the personnel side of leadership work. This is particularly clear in situations where parental concerns about a teacher's language, relational competence, or teaching practice overlap with internal tensions or collaboration problems among staff. In such cases, the matter is no longer only about pedagogical quality or parent-school relations. It also becomes a personnel issue that may involve follow-up of an individual staff member, concerns about the working environment, and questions about how the case should be handled in a legally proper way. At the same time, the leader must take account of the pupil's right to a safe and high-quality provision and the parents' concerns. This supports an understanding of employment law as an integrated part of pedagogical practice rather than a side field detached from the core activity [18] [19] [21]. In this way, parents' perspectives appear as an active part of how legal risk develops and how such personnel-related conflicts must be handled in practice.

Staff Professional Practice and Employment-Law Frameworks as Legal Risk and Legal Handling

Employment-law issues appear as the largest area of risk in the material. Sick leave and workplace accommodation emerge as legally demanding aspects of leadership practice. The same applies to poor work performance, redeployment, and dismissal. Downsizing and the limits of managerial prerogative also stand out as legally difficult areas. Such matters affect the organisation's operation and may also have implications for quality. At the same time, they often shape relationships within the workplace and between the institution and its wider stakeholders. Such descriptions reinforce the view that employment law is an integrated part of the leader's everyday responsibility for sound operation and pedagogical quality, rather than a specialist field separate from the core activity [18] [19]. Cases concerning sick

leave and accommodation make this especially clear. Leaders describe an ongoing tension between taking care of staff and at the same time ensuring stability and quality for children and pupils.
This tension also becomes visible in how such matters are handled in practice. Handling is not just about meeting legal requirements. It involves ongoing practical work: preparing follow-up plans, assessing work capacity, discussing possible measures, and securing substitute staff when needed. These tasks require leaders to balance the needs of individual employees against the pressure to maintain stable daily operation. As one leader notes, much time is spent on "*staff scheduling, recruitment of substitutes, and follow-up of employees on sick leave,*" leaving less time for professional leadership and quality development. In this way, legal handling becomes a form of leadership work that must hold together documentation, procedural follow-up, and everyday operations at the same time.
Accommodation also appears as more than an individual matter. Consideration for the employee must be balanced against the needs of children and pupils, the workload of colleagues, and the overall running of the organisation. Employment-law assessments therefore also become organisational and pedagogical assessments. What becomes visible here is that accountability extends beyond formal lines of authority, as leaders must respond both to expectations from higher levels of the system and to those arising from colleagues, parents, and professional communities (Hupe & Hill, 2007). From a Bolman and Deal (2024) perspective, these cases are shaped both by structural demands and by human resource concerns. These problems often emerge gradually. Firstly, these issues rarely present themselves as clearly defined cases. Rather, they tend to develop through absence, reduced work capacity, collaboration difficulties, and poor work performance. When staff "often engage in hidden accommodation" for colleagues with health-related challenges, loyalty and relationships may both reduce and increase risk. Practices of this kind can delay leadership oversight and make it harder to assess the need for formal measures. The pattern is consistent with an understanding of organisations as both structural and relational systems, in which informal practices influence how formal rules actually work [8].
Cases involving reorganisation, allocation of work tasks, redeployment, and downsizing appear especially uncertain and serious. They affect relationships, loyalty, and trust. They also influence the working environment beyond the individual case. The descriptions therefore suggest that employment-law risk is linked not only to individual decisions, but also to organisation, lines of responsibility, and the sustainability of the overall operation. Increased rule governance does not necessarily reduce the space for discretion, especially in cases where standardised solutions are not enough [12].

Legal Risk and Legal Handling at the Intersection of Documentation, Time Pressure, and Relational Vulnerability

The analysis indicates that legal risk in schools and early childhood education and care settings is not only about the possibility of making decisions that may later be challenged. It is also about leaders' ongoing work to find ways forward that can be defended both legally and professionally. Across the different areas, documentation, time pressure, and relational conditions repeatedly shape the situations leaders face. In turn, these factors influence both how legal risk arises and how it can be handled. Documentation becomes crucial for legal protection and accountability. At the same time, it often has to be built up during cases marked by incomplete information. Time pressure intensifies the complexity further because assessments and priorities must be made under uncertainty. This is closely aligned with descriptions of decision-making in welfare organisations under conditions marked by ambiguity and limited resources [15] [20]. At the same time, relational vulnerability ties the other dimensions together. Conflict, trust, and the sharing of information affect both the basis for assessment and the possibilities for action. This is consistent with research that highlights dialogue, ethical orientation, and relational grounding as central conditions for leadership in complex professional organisations [1] [3] [34]. Taken together, the findings indicate that legal risk arises at the intersection of law, organisation, and relationships. The handling of such cases therefore appears as an integrated part of everyday leadership practice.

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The Impact of Artificial Intelligence on Writing and Speaking Practices among EMI and ESL Students: Sociolinguistic and Pragmatic Perspectives

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Abstract

The rapid integration of language tools powered by artificial intelligence (AI) into higher education has introduced significant cognitive, pedagogical and sociolinguistic implications, particularly for non-native English-speaking university students. This study investigates the evolving impact of AI-assisted writing and speaking tools on second language (L2) development within the academic context. The article is grounded in applied linguistics and second language acquisition theory and examines how sustained reliance on AI-generated language support may influence the learners' linguistic competence, conceptual understanding, cognitive processing, critical thinking and academic voice. Moreover, it analyzes the potential alterations in lexical precision, grammatical accuracy and pragmatic awareness in AI-mediated academic text and speech generation. Using a mixed-methods design, the study will combine quantitative and qualitative analyses. The findings aim to clarify whether AI primarily performs the role of a scaffold that promotes language development (Vygotsky, 1978) or that of a compensatory mechanism that may inhibit deeper cognitive and linguistic processing (Swain, 1985). By placing AI within existing frameworks of second language acquisition, academic discourse development and language pedagogy, the research contributes empirical evidence to ongoing debates that regard AI integration in higher education. Additionally, the study offers pedagogical recommendations for educators and policymakers seeking to optimize AI-assisted learning while reducing the potential negative impacts on language acquisition, conceptual understanding, cognitive processing and critical thinking.

Keywords: *AI-assisted language learning, digital communication, cognitive processing and critical thinking, writing and speaking techniques*

Introduction

In today's digital era, artificial intelligence has become an indispensable agent in digital communication, fundamentally altering the linguistic and the sociolinguistic conditions in which language is produced and identity is conveyed. Systems such as large language models, predictive text engines and smart-reply tools no longer serve as mere supplementary mechanisms for human expression; they function as co-producers of discourse, tangibly influencing and oftentimes directly shaping the speaker's lexical choice, syntactic structure, emotional tone and the social meanings embedded in language (Hohenstein et al., 2023; Hancock, Naaman, & Levy, 2020).

This article examines the emerging processes and subsequent transformations from the perspectives of sociolinguistics, applied linguistics and second language acquisition, paying particular attention to the implications of AI integration for language: the lexical choices speakers and writers make, the syntactic structures they construct and the discursive voice they are able to maintain.

The paper consists of four sections. The first section examines how AI reallocates communicative power and reshapes processes of self-representation in everyday written language. The second section explores the measurable effects of AI-assisted writing on sentence structure and lexical efficiency. In the third section the paper investigates the issue of cognitive offloading and the eventual implications of delegating linguistic decision-making to machine systems. Ultimately, the fourth part of the study focuses on learners in English-medium instruction (EMI) and English as a second language (ESL) contexts, students for whom AI may simultaneously function as a cognitive scaffold and as a potential substitute for the development of linguistic competence.

All four perspectives pointed out above address one central question: whether AI supports the developmental processes through which language is acquired and individual voice is formed, or whether AI progressively replaces them.

Artificial Intelligence and the Reshaping of Communicative Power and Practices

When discussing AI and human communication in terms of linguistic interface, the concept of asymmetrical accommodation, an extension of Giles' (1973) *Communication Accommodation Theory*, is central in providing the most productive analytical insight for understanding human-AI linguistic interaction. In human interaction, the adjustment is normally bidirectional, meaning that interlocutors mutually adjust their language in response to social signals such as the tone, gestures, word choice, conversational context and so on. However, human-machine interaction may partially or sometimes completely disrupt this symmetry. Users routinely simplify their syntax, over-articulate their pronunciation and limit their lexical range in order to accommodate the perceived limitations of the system; the system, however, accommodates only within the parameters set by its training data and operational design. Consequently, one party continually adapts while the other sets the terms of intelligibility (Mieczkowski et al., 2021). This kind of continuous imbalance may substantially alter the existing communicative norms, gradually restricting the range of expression that people feel comfortable or willing to use.

Analyzing real-life scenarios, smart-reply systems such as Gmail's AI-generated response suggestions represent one of the most invasive, prevalent and empirically well-documented sources of AI influence on everyday written language. Hohenstein et al. (2023) demonstrated, in a large-scale study, that the use of such suggestions can indeed systematically increase the positivity of message content, however, it imposes the risk of simultaneously reducing the variation in word choice among users. Algouzi and Alzubi (2023) extend this finding to cross-cultural contexts, documenting the loss of culturally specific linguistic markers as users rely on AI-provided templates. From the sociolinguistic perspective, the implications are tangible: every individual choice to accept a suggested reply represents a small contribution to the homogenization of written English (Jean, 2023). Eventually, this mechanism leads to a subtle and a gradual form of standardization.

The present discussion incorporates the affective dimension of AI-mediated text, which is an important component of this study. Research conducted at the Max Planck Institute confirms that AI-mediated communication tends to be more polite, more concise and more positive than that of natural spontaneous communication. Hohenstein et al. (2023) confirm this pattern across various communicative settings, showing that the positivity preference introduced by suggested language persists even when users believe they are writing independently. This reveals a central paradox; the same features that make AI-generated language tempting — fluency, a controlled tone and reduced communicative friction, may also weaken the authenticity of the messages it produces. As written communication becomes noticeably smooth and polite, the distinctive elements of individual voice, such as rhythm, idiomatic usage and lexical preference, tend to decrease.

One of the most significant dimensions of AI's sociolinguistic influence is the unpredictable rearrangement of communicative power, which happens when AI systems provide generated templates through which institutional communication is conducted. This can lead to a significant extension and alteration of dominant normative forms (Massaad, 2025). In professional and legal settings, where AI may assume responsibility for approximately 70 to 80 per cent of routine document drafting, such systems pose a high risk of becoming central mechanisms for the production and reproduction of institutional knowledge, potentially reallocating traditional authority while simultaneously concentrating linguistic power in the hands of those who design and deploy them (Lardy, 2024).

Ultimately, these findings describe a substantial sociolinguistic transformation. Artificial intelligence has become a fundamental participant in the production of contemporary discourse, reorganizing lexical choice, syntactic form and emotional tone. Its presence alters the dynamics through which identity is shaped in writing, and redesigns the conditions in which linguistic diversity is maintained.

Sentence Length and Lexical Conciseness Affected by AI

Having increasingly influenced the English language, the recent technological advancements in the context of digital communication have had their impact not only on sociolinguistic capacity and communicative self-representation but also on sentence complexity and lexical conciseness. The emergence of Artificial Intelligence (AI), particularly generative AI systems such as OpenAI's ChatGPT, publicly released in November 2022 (OpenAI, 2022), has introduced an unprecedented dimension to linguistic transformation. Since its release, AI has remarkably affected the ways individuals produce and consume language in online environments. Its influence can already be observed in vocabulary expansion, increased linguistic conciseness, automated grammar correction, stylistic standardization and the growing use of AI-assisted communication in academic, professional and everyday contexts.

Recent research has emphasized that AI-powered language models are reshaping digital discourse and altering human interaction with written language (Brown et al., 2020).
In this section, the paper addresses the impact of Artificial Intelligence on the English language, with particular attention to changes in vocabulary, grammar, conciseness and digital communication practices in our days. As outlined above, a central focus of this research is the impact of artificial intelligence on syntactic organization and lexical efficiency in written English. According to findings presented by Karolina Rudnicka (2025), AI-supported writing systems such as ChatGPT and Grammarly consistently generate outputs that are more compact with shorter sentence length and lower levels of lexical repetition. An important element here is that these patterns are also evident in texts that are produced by native speakers and sourced from contemporary corpora, indicating that the observed changes are not restricted to new language learners but encompass broader processes of text adjustment and language optimization.
The empirical basis of the study consists of a case analysis involving one hundred randomly selected sentences drawn from the Corpus of Contemporary American English, a comprehensive corpus of modern American English spanning the period 1990–2019 and consisting of multiple registers, including academic prose, fiction, journalism, blogs, spoken discourse and digital communication. Through systematic comparison of original and AI-modified sentence versions, the research identified a consistent shift toward simpler sentence structure, shorter, more direct wording, and enhanced readability.
Overall, the results indicate that AI-based writing technologies tend to reshape linguistic production by encouraging more simplified, standardized and reasonably structured forms of expression in both academic and digital contexts.
The findings further demonstrate that, despite their differing functional roles, both Grammarly and ChatGPT produce broadly homogenized and aligned linguistic effects. As Rudnicka observes, both systems regularly promote concision by eliminating redundancy and frequently omitting formal constructions such as "in order to," irrespective of sentence complexity or register variation. This indicates a systematic bias toward conciseness over stylistic diversity or rhetorical tone. In fact, the findings additionally reveal a reduction in mean sentence length, however, this change does not necessarily correspond with improved readability outcomes. Rather, the evidence suggests that these tools primarily prioritize textual compression and structural simplification rather than communicative optimization.

When Machines Write: AI, Cognitive Offloading and English as an Intellectual Tool

"We have become intellectual tourists in our own work. We visit ideas. We don't inhabit them" (Sarkar, 2025, p. 2).
This is the central concern of Sarkar's (2025) talk at TEDAI Vienna, published as an annotated transcript under the title *Artificial Intelligence as a Tool for Thought.* Sarkar, a researcher at Microsoft Research Cambridge, opens with a scene that will feel familiar to anyone who has spent time in a modern office: emails, summaries, reports drafted, data analyses, desks assembled, all with AI assistance, all within the span of a single morning. This image of intellectual tourism is more than a rhetorical expression. It captures something truthful about the relationship between the knowledge worker or the student, and the language they produce when AI mediates between thought and text.
In terms of cognitive offloading and English language as a cognitive tool, the evidence gathered by Sarkar carries an important weight, since it since it conveys a profound analysis of how language functions cognitively. When analyzing creativity from the perspective of this AI-mediated communication and English language, Sarkar points to his own earlier research to describe what he calls "mechanized convergence", the documented tendency of groups working with AI assistance to produce a narrower range of ideas than groups working without it (Sarkar, 2023). This finding has an obvious linguistic dimension; language diversity, the range of lexical choices, syntactic structures and rhetorical strategies that writers bring to a task, are not merely aesthetic features of good prose. They reflect the diversity of thought itself. When AI narrows the range of ideas, it also, quietly and gradually, narrows the range of linguistic resources available to express them.
In terms of critical thinking, it is important to point out a survey by Lee et al. (2025), in which knowledge workers reported putting evidently less effort into critical reasoning when working with AI. And what is even more prominent, this reduction was greatest among those who trusted AI most and doubted themselves most, a pattern that should give language educators particular thought. The learner who is least confident in their own English is precisely the learner most likely to rely on AI-generated text, and most likely to miss the language-learning opportunity that is provided by productive "struggle". The

findings concerning memory are equally pointed out; Sarkar (2025) refers to research showing that people remember less of what they wrote when they relied on AI to write texts, and a randomized experiment conducted by Kreijkes et al. (2025) in secondary schools found that students using large language models as their primary reading aid showed lower comprehension and retention than those who engaged with texts directly.
Linguistically, what is probably most significant in Sarkar's research is his approach to metacognition, the capacity to reflect on one's own thinking and on one's own language choices. Sarkar states that working with AI requires metacognitive effort; one must assess the AI's output, decide whether it reflects one's intentions and judge whether the words on the page are actually theirs. But crucially, this metacognitive demand arises precisely because of the direct engagement with language, the sentence-by-sentence text production as to how to say something, has been delegated to the machine. Tankelevitch et al. (2024) describe this as a structural change in the cognitive demands of knowledge. According to their findings, AI does not eliminate the need for thinking, but rather changes the way thinking is performed. Instead of actively engaging in the cognitive process of formulating ideas through language, users increasingly adopt a more detached and evaluative role, focused on reviewing and refining AI-generated content. In this sense, the individual no longer functions primarily as the author of the text, but rather as the editor of a draft produced by the machine as described by Sarkar (2025). This distinction is particularly significant for language development. Swain (1985) identifies the following process as a fundamental element to second language acquisition: the moment in which the learner must search for a word, navigate through a grammatical structure, or formulate an argument in a language that is not yet fully mastered, arguing that these steps are essential for linguistic development. In this perspective, the analogy Sarkar embraces from Bainbridge (1983) is particularly relevant. Bainbridge described the “ironies of automation” as the paradox where systems designed to reduce the workload of human operators tend to gradually weaken the skills that are required when those systems fail. Writers and language learners who consistently delegate linguistic decision-making to AI may face a similar risk. The cognitive and linguistic abilities developed through the processes of writing, noticing, selecting, revising and committing to linguistic choices are not fully maintained through the passive evaluation of AI-generated text. Instead, these skills may gradually weaken over time, often remaining unnoticed until they are required independently and can no longer be effectively performed.

Cognitive, Pragmatic and Sociolinguistic Dimensions of AI in ESL

The integration of generative artificial intelligence into higher education has acquired particular significance for students operating within English-medium instruction (EMI) and English as a second language (ESL) context. For these students, AI tools function not merely as instruments of efficiency, but as cognitive and linguistic frameworks that may either support or substitute the developing competence of the second language user. Youvan (2024), in his extended analysis of artificial intelligence as an instrument for cognitive augmentation, introduces a series of arguments from the perspective of applied linguistics that highlight the changes currently occurring in academic writing and speaking practices among multilingual students. This section synthesizes Youvan’s contribution through three convergent perspectives: cognitive, pragmatic and sociolinguistic, and considers the pedagogical implications that follow.
In terms of cognitive function, Youvan (2024) claims that human thought has always been bounded by the limits of natural language. The memory limitations first formalized by Miller (1956) and refined within Baddeley's (2003) model of working memory, impose particular burdens on learners who are required to compose in a language that is not their own. For EMI and ESL students, the cognitive load associated with academic production in English is substantially greater than that experienced by first-language speakers, since lexical search, syntactic structuring and rhetorical organization must each be conducted within a partially acquired linguistic system (Sweller, 1988; Kormos, 2012). AI-assisted writing tools may reasonably offload portions of the cognitive burden of surface-level production, allowing students to direct attention toward higher-order rhetorical and conceptual concerns. The major risk, however, is precisely the one Youvan himself identifies in his closing reflections, that over-reliance upon AI may inhibit the productive process through which language acquisition is consolidated.
The pragmatic dimensions of AI mediation are equally significant, though Youvan (2024) addresses them only indirectly. Pragmatic competence, the capacity to adjust language to context, audience and communicative purpose, is among the most demanding dimensions of second language proficiency to develop, partly, because it cannot be acquired through grammatical instruction alone (Bardovi-Harlig, 2013). For EMI and ESL students, the disciplinary conventions of Anglophone academic writing such as citation practices, evaluative stance and the management of academic voice, constitute a sustained

pragmatic challenge (Hyland, 2005). AI-mediated writing tools can produce text that is superficially compliant with these conventions, yet the deeper pragmatic reasoning that underlines expert academic discourse remains poorly modelled by current systems. Empirical work by Algouzi and Alzubi (2023) on AI-mediated reply suggestions, and research by Hohenstein et al. (2023) on the systematic positivity bias of AI-generated text, indicates that contemporary AI tools tend to converge toward a narrow band of pragmatically safe formulations: fluent, courteous but pragmatically generic.

From a sociolinguistic perspective, the integration of AI into second language writing raises significant questions of identity, voice and the distribution of linguistic authority. Academic writing is not the neutral transmission of information but the discursive construction of an authorial self within a scholarly community (Ivanic, 1998). For EMI and ESL students, the development of a recognizable academic voice in English constitutes simultaneously an intellectual achievement and a form of social positioning, signaling both competence and membership within a community of practice (Lave & Wenger, 1991). Youvan (2024) raises the concern that intellectual homogenization may emerge as an unintended consequence of widespread AI use; the sociolinguistic implications of this risk are particularly elevated for second language writers. The phenomenon resembles what Sarkar (2023) has termed "mechanized convergence": a gradual narrowing of academic writing toward a limited and more homogeneous style, caused not by formal rules but by the repeated use of similar AI-generated patterns.

These three perspectives — cognitive, pragmatic and sociolinguistic, are not separable concerns but interlocking dimensions of a single transformation. The capacity of artificial intelligence to reduce the cognitive load of L2 production is inseparable from its tendency to standardize pragmatic choices; the pragmatic effects of AI mediation are themselves embedded within the sociolinguistic dynamics through which linguistic norms are reproduced. For EMI and ESL students, the central question is no longer whether or not to engage with this technological shift, since the integration of AI into their writing and speaking practices has already significantly advanced, but rather in what conditions this engagement should take place. The pedagogical response, as Sarkar (2025) and Buçinca, Malaya and Gajos (2021) have separately argued, remains in the thoughtful and strategic projection of AI interaction, that does not diminish the productive cognitive effort, but on the contrary, preserves it.

Conclusion

The overall investigation and analysis carried out across the four sections, examining how generative artificial intelligence is reshaping the writing and speaking practices of ESL and EMI students, lead to the following conclusion; AI is no longer an external assistance to second language production but an active participant in it, shaping the words students choose, the structures they build and the voice through which they are recognized within an academic community. For learners who are still acquiring the language, the potential risks associated with the constant integration of AI-mediated text and speech assistance into their language development may be remarkably high.

We have examined whether AI operates as a scaffold that supports language development or as a replacement mechanism that substitutes for it. The answer is contradictory rather than definitive. AI-assisted tools can reasonably moderate the cognitive load associated with surface-level text production, allowing EMI and ESL students to direct their attention toward higher-order rhetorical and conceptual concerns. However, when used without critical evaluation and reflection, these same tools may diminish the productive process that Swain (1985) identified as central to second language acquisition. When that process is delegated to the machine, the developmental opportunities inherent in language production may consequently be reduced.

When analyzing written texts in English, the effects of AI are more consistent and measurable. AI-assisted writing tools systematically shorten sentences, reduce lexical variation and lead toward more concise, courteous and statistically default formulations. For L2 students this might carry a particular risk and cost; the conventional norms of academic writing, including evaluative stance, citation practices and the organization of academic voice, are exactly the pragmatic competences that AI can reproduce, while leaving the underlying reasoning underdeveloped. Therefore, a student may submit text that is completely compatible with conventional academic norms and requirements, yet, the same student has not learned to produce the text independently. In such cases, the produced text may reflect more of a technical compliance rather than genuine linguistic development or critical engagement with academic discourse. As a result, learners may become increasingly dependent on externally generated formulations instead of developing the cognitive and rhetorical skills required for self-sufficient academic writing

Despite individual competence, the article highlights a sociolinguistic risk for multilingual students. The fact is AI systems trained on standard varieties of English may promote linguistic homogenization,

gradually narrowing linguistic diversity toward a homogenous stylistic form. As a result, the distinctive voices and cultural perspectives of L2 students in global Anglophone discourse may be critically diminished.

However, in conclusion, the pedagogical solution is not to separate AI from language learning, but to integrate it purposefully and thoughtfully. Educational tools and tasks should preserve productive cognitive effort by prioritizing engagement over rapid task completion. In this way, AI can support and enrich language development rather than replace it. Positioning learners as active authors of their own writing and speaking, rather than mere editors of machine-generated text, has become a central concern in applied linguistics, language education and educational policy.

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Designing Web Programming Course with Trend of Labor Market in Gen AI Driven World

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Abstract

Programming education remains a major challenge in undergraduate computing programs. Learning to program is not just about understanding a language's syntax; it also involves developing important cognitive skills such as computational thinking, abstraction, algorithmic reasoning, and structured problem-solving. In addition, students need soft skills like teamwork, critical thinking, and reflective thinking to succeed in real-world software development. The rapid growth of generative artificial intelligence (GenAI) is transforming how software is developed. While GenAI tools can automate routine programming tasks, they require developers to gain new skills in AI-assisted software development, system integration, and higher-level problem-solving. As a result, universities must rethink and update their programming curricula to meet changing industry demands. This paper explores how a programming course like web programming can be redesigned to include GenAI-related skills. Using web programming as a case study, we apply a proposed teaching framework to design a course that integrates both industry expectations and GenAI competencies. The goal is to better prepare students for GenAI-augmented software development roles and to support sustainable curriculum design in the age of generative AI.

Keywords: *Generative AI, Effective Teaching Framework, Programming Pedagogy, Higher Education.*

1. Introduction

In higher education digital age, there is a rising demand for programming talent. Companies worldwide consistently recruit programmers to address their digital needs, leading to an increase in student interest in the field from a broad range of backgrounds [1]. In response, a wide range of educational providers including schools, universities, coding bootcamps, and online learning platforms have expanded their programming curricula [2]. Despite this growth, a challenge persists: the need to design and implement effective pedagogical frameworks that not only support foundational programming competencies but also align with the rapidly evolving labor market. This challenge is particularly significant in the context of generative artificial intelligence (GenAI), which is transforming software development practices and redefining the skills required of future computing professionals [4]. Generative AI technologies have two main impacts on the labor market: on the one hand, workforce substitution occurs as technology replaces certain specialists by performing tasks autonomously, which represents a negative impact; on the other hand, these technologies drive new employment creation and professional transformation, as industries and businesses demand new skills and experience to work with generative AI technologies, representing a positive impact. It is critical to investigate the changes in the list of expected skills on the labor market in software development associated with new generative AI technologies. This allows education institutions to analyze and adapt curriculum development according to new skills that are in demand in the job market [4][5]. Figure 1 shows what GenAI tools and skills are demanded by industry in area of software development from employees.

Existing research on GenAI in education has largely concentrated on issues such as academic integrity, ethical considerations, and the broader influence of GenAI on teaching and learning practices. To date, most educational applications of GenAI have emphasized AI literacy initiatives, the development of institutional policies, and its role in writing-based assessments. In contrast, comparatively little attention has been given to the incorporation of GenAI into teaching framework for software development and programming education [6]. It is, thus, essential to have an effective GenAI powered teaching framework for software development and programming in higher education (HE). A teaching framework that provides principles, guidelines, methods, and techniques to help instructors understand how students learn and, consequently, how to teach effectively [2]. This framework should utilize AI-powered educational technologies to enhance teaching and learning effectiveness.

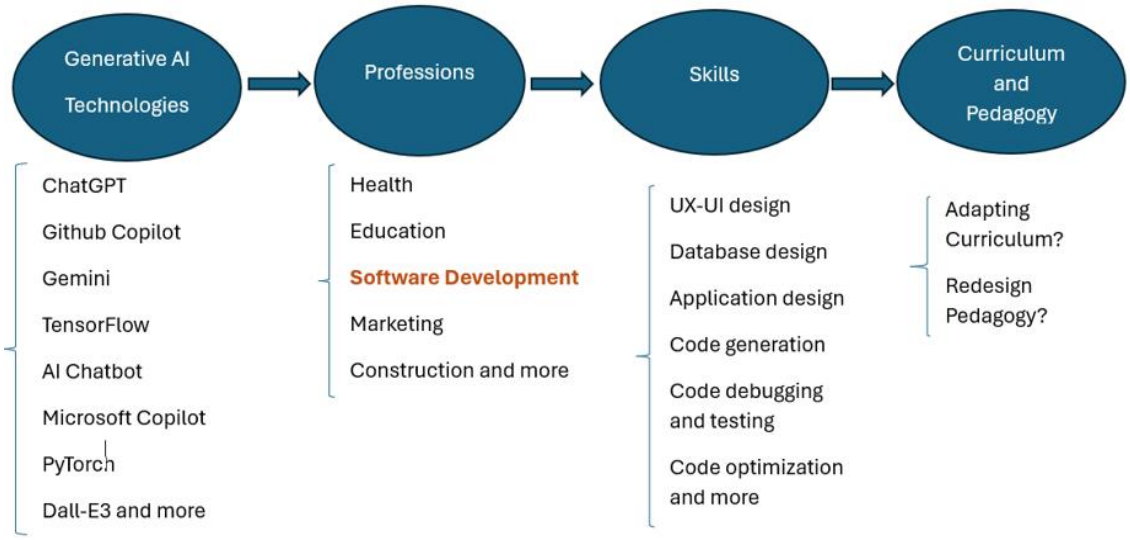


Fig. 1. GenAI Related Skills in Software Development

In this paper, we follow our proposed teaching framework in [7] and build a teaching framework for one of programming courses in HE called Web Programming. This framework presents a GenAI-empowered, group-based authentic designed for a Web Programming course. Specifically, the present work addresses the following research questions:

1. How can an effective teaching and learning framework be designed for programming courses to enhance student learning while aligning with industry-relevant skills?
2. How can generative AI be actively integrated into programming pedagogy to improve student learning outcomes while minimizing risks to academic integrity?

The remaining paper is organized as follows. Section 2 discusses our proposed teaching framework, and section 3 outlines the process of framework implementation for our web programming course. Finally, conclusions are presented in section 4.

2. Proposed Teaching Framework

Our previous paper [7] focused on programming pedagogy and in that work, we identified the essential components needed to build an effective teaching framework for programming which are elaborated further in the below (shown in figure 2).

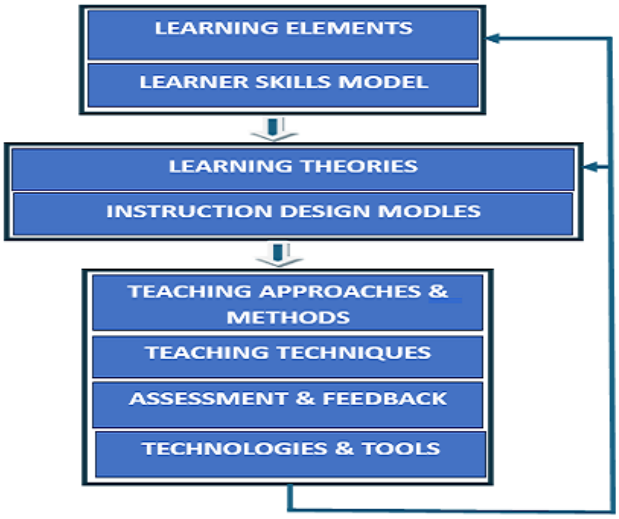


Fig. 2. Essential Components for Teaching Framework

A. Programming Learning Elements (Topics): refers to the core components of knowledge that students must learn in a programming course. It represents the building blocks of programming learning

objects including syntactic knowledge (language rules), conceptual knowledge (how constructs program), and strategic knowledge (how to apply them to solve problems).
B. Learners Skills Model: describes the progression of skills that students are expected to develop throughout a programming course. This model provides a structured view of skill development that supports course design, instructional planning, and assessment.
C. Learning Theories: Learning theories provide the pedagogical foundation for designing effective programming courses by explaining how learners acquire knowledge and learn.
D. Instructional Design Models: Instructional design models provide systematic approaches for planning, developing, and evaluating teaching and learning processes.
E. Teaching Approaches and Methods: Teaching approaches are the overall educational philosophies or strategies that guide instruction. Examples include teacher-centered and learner-centred approaches. In contrast, teaching methods are the specific activities used to implement those approaches in the classroom. Examples include hands-on labs, coding exercises, projects, group work, and discussions.
F. Teaching Techniques: Teaching Techniques are the specific, practical actions and tactic an instructor uses in implementation of a teaching method to support learning. For instance, in pair programming methods, the instructor can use a driver/navigator strategy (one student codes and the other reviews it).
G. Assessment and Feedback: Assessment and Feedback refer to the processes used to measure student learning and provide information that helps learners improve their performance. In education, especially in programming courses, assessment and feedback are essential for evaluating learning outcomes and guiding skill development.
H. Technologies and Tools: Technology has become a powerful educational tool, transforming how students learn, and teachers instruct. Digital devices, software, and internet-based resources enable a more interactive, personalised, and engaging classroom learning experience.
In next section, we describe the process of teaching framework implementation for our web programming course.

3. Teaching Framework Implementation for Web Programming Course

We selected web programming as case study for our study. Web programming has become a foundational skill in modern computing education due to the rapid growth of web-based applications, services, and platforms across nearly all industries. From e-commerce and social networking to data visualization and cloud services, the web has evolved into a primary medium for software deployment. As a result, higher education institutions face increasing pressure to design web programming courses that not only teach technical skills but also prepare students to adapt to continuously changing technologies and development practices. Instructors must balance fundamental concepts such as client–server architecture, HTTP, and web security with practical skills including front-end and back-end development, database integration, and responsive design. Normally this course is offered for second year students for Bachelor of Computer Science related programs. Additionally, students often enter these courses with varied backgrounds in programming, which further complicates course design and instructional strategies [8][9]. This paper explores the design of a web programming course that addresses these challenges and considering industry and GenAI related skills adapted to labor market demand, emphasize on hands-on learning, progressive skill development, and the integration of real-world development practices. By focusing on both conceptual understanding and practical application, the course aims to enhance student engagement, improve learning outcomes, and better prepare students for professional web development environments. The remainder of this paper describes the development of teaching framework for a web programming course.

3.1 Learning Objects Model for Web Programming

To design an effective teaching framework, instructors must first identify the core learning elements of programming courses. Prior works have classified programming knowledge into syntactic, conceptual, and strategic categories, encompassing language syntax, underlying principles, and logics [10][11]. Considering this, the learning elements of programming courses are organized into four categories: logic, programming language, programming (code), and tools. Each category includes key learning elements, such as writing, executing, and debugging code. Table 1 outlines learning objects for our web programming course and provides basis for defining learning objectives in web programming courses.

Table 1. Learning Object Model for Web Programming

Logic	Programing Language	Program/code	Tools
Computationally analyzing problem	Concepts and constructs	Write program	Code generation
Logic language	Syntax	Build and run	Build automation
Design algorithm	Design patterns and libraries	Debug and test	Debugging

3.2 Student Skills Model for Web Programming

We draw a skill model for web programming course under the models suggested by SFIA [12], CC2020 [13] and IT2017 reports [14]. The proposed model in table 2 consolidates the core hard and soft skills required for a web programming course. By categorizing skills according to type and proficiency level, the model provides structured guidance for syllabus design, informing the selection of learning materials, instructional methods, and classroom activities. Furthermore, the skill model serves as a reference point for evaluating the effectiveness of teaching methods and pedagogical techniques. By aligning instructional practices with clearly defined skill categories, instructors can more systematically articulate learning objectives and assess whether course outcomes are being achieved at both the lesson and program levels.

Table 2. Skill Model for Web Programming

Soft Skill	Professional Skills				
	Problem Solving			Critical Thinking	
	Behavior / Attitude				
	Motivation	Communication	Teamwork	Self-efficacy	Time Management
Hard Skill	Design Skills				
	Algorithm	Conceptual Knowledge		Syntactical	
	Implementation Skills				
	Strategical Knowledge	Test and debug		Tools	
	Generative AI Skills				
	Algorithm design			Code generation	

3.3 Learning Theory for Web Programming

It is important for instructors to base their teaching on appropriate learning theories, as these theories provide clear principles for how learning should take place. Learning theories guide the design of teaching approaches, methods, and classroom activities, ensuring that instruction is effective and aligned with how students learn best [15]. One widely used theory in practical and skills-based courses is constructivism. This theory suggests that learners build new knowledge by connecting new ideas to their previous experiences and existing understanding. Students develop deeper understanding by reflecting on and refining their prior knowledge. In practice, constructivist teaching strategies include problem-based learning, project work, research activities, and group collaboration [16].
We selected constructive learning theory as effective learning theory for our web programming course because:
- Learning by doing mirrors real-world web development
- Encourages problem-solving and critical thinking
- Constructivism values social interaction in knowledge construction. web programming naturally supports this through pair programming, code reviews, and group projects.

3.4 Instructional Design Model

Instructional design is a systematic process for developing effective teaching materials, learning activities, and instructional strategies to improve educational outcomes. Instructional design models provide structured guidance for instructors in planning and organizing educational programs, courses, or individual lessons. By following these models, educators can ensure that learning objectives are clearly defined, aligned with instructional activities, and effectively achieved [18]. We used ADDIE Model as a standard instructional design model including a five-phase model (Analysis, Design, Development, Implementation, and Evaluation) that provides a step-by-step approach to developing instructional materials. The ADDIE instructional design model is suitable for web programming courses because Its flexibility supports continuous improvement and provides a systematic framework for analyzing learner needs, designing structured learning experiences and evaluating both learning outcomes and instructional effectiveness.

3.5 Teaching Approach, Methods and Strategies for Web Programming

The student-centered approach is the most effective in involving learners and giving them responsibility for their learning path and progress [19]. Overarching within a teaching approach are the multiple teaching methods that develop depending on the principles of the teaching approach. A teaching method is a series of step-by-step actions teachers and students undertake to achieve specific learning objectives. Luxton-Reilly [10] describe a range of teaching methods based on a student-centered teaching approach for teaching programming. Practical examples of these methods for instructors in programming courses are project-, problem-, case-, and inquiry-based learning methods, as well as gamification, flipped-the-classroom, live-coding, and peer-instruction methods. In contrast, teaching strategies are the styles and tactics used in the classroom, sustaining a specific teaching method to accomplish a learning objective effectively. For instance, in pair programming, often used within project-based methods, the instructor can use a driver/navigator strategy (one student codes and the other reviews it), an unstructured strategy (two students work together in an ad hoc manner), or a ping-pong strategy (one student writes code and the other tests it, shifting roles regularly). Hence, instructors must be equipped with a palette of expertise to select and apply effective teaching methods and strategies, guided by the fundamental principles of the learning theory, instructional design model, learning elements, and an evaluation of students' skill levels, as discussed above [19][20].

Generative AI is transforming teaching and learning methods by shifting instruction from content delivery toward guided knowledge construction and higher-order thinking. Tools such as ChatGPT, Google Gemini, and Claude can generate explanations, examples, practice problems, simulations, and formative feedback on demand, enabling highly personalized and adaptive learning pathways. Instructors can use generative AI to design differentiated materials, create scenario-based learning activities, and automate feedback cycles, thereby freeing time for mentorship and conceptual discussion. For learners, these systems support idea generation, and iterative refinement of work, which can enhance metacognitive awareness and self-regulated learning [21][22][23].

Considering the effectiveness of various teaching methods and the emerging impact of GenAI, we adopt the following methods and strategies for delivering the web programming course in upcoming semester (as shown in figure 3):

- GenAI-powered flipped classroom: The flipped classroom is effective for web programming courses because it shifts content delivery outside the classroom and uses in-class time for hands-on coding, problem-solving, and collaboration. This approach supports active learning, accommodates diverse learner backgrounds, and enhances students' ability to apply programming concepts in real-world contexts. To support this, for each session we provide pre-class reading materials, short instructional videos, sample code demonstrations, and access to an online discussion forum. Additionally, students are encouraged to interact with GenAI as a "pre-class tutor," asking clarification questions and testing understanding before attending class. This Promotes self-regulated learning and prepares students for deeper in-class engagement. During class, generative AI is used to support higher-order learning activities such as analysis, evaluation, and collaborative problem-solving. Learners critically examine, refine, and compare AI-generated outputs with their own generated output. For mastery enhancement, students are encouraged to use generative AI after class to discover advanced solutions as well.
- Project based: Project-based teaching is effective for web programming courses because it integrates theoretical instruction with authentic, hands-on projects. This approach promotes active learning, enhances problem-solving skills, increases student engagement, and aligns academic learning

with real-world web development practices. We start with a real-world project that integrates core web technologies such as E-commerce web applications. We break the course into structured development phases and instruction is structured around iterative project milestones including requirements analysis, interface design, backend implementation, integration, testing, and deployment. Students are required to engage with GenAI as an object of critique and inquiry, which in turn strengthens their critical thinking skills, metacognitive awareness, collaborative engagement, and AI literacy.

- Live coding with GenAI powered pair programming: Live coding is effective in web programming courses because it shows real coding practices, makes problem-solving and debugging visible, and connects theory to hands-on work. Combining live coding with pair programming improves engagement, reduces cognitive overload, and models expert thinking. We use a driver/navigator strategy that one student will do coding, and the other student will review it. GenAI systems like ChatGPT add a new dimension by acting as adaptive collaborators that can generate code, explain logic, suggest alternatives, and simulate edge cases. In our approach, the instructor codes live while students query AI for alternatives and compare human versus GenAI reasoning.
- Lab learning activities provide a structured, hands-on environment that enhances both individual and collaborative learning in programming courses. During lab, instructors conduct workshops on coursework offer students dedicated time to apply theoretical concepts, experimenting with code, and receiving immediate guidance from instructor, fostering deeper comprehension and practical skills. Mini presentations of coursework progress during lab sessions, encourage students to articulate their problem-solving approaches, reflect on challenges, and gain constructive feedback, promoting self-regulation and communication skills essential for software development.
- knowledge check: End-of-lecture live quizzes are effective in web programming courses because they reinforce newly introduced concepts, provide immediate formative feedback, and support active engagement and early identification of learning gaps.

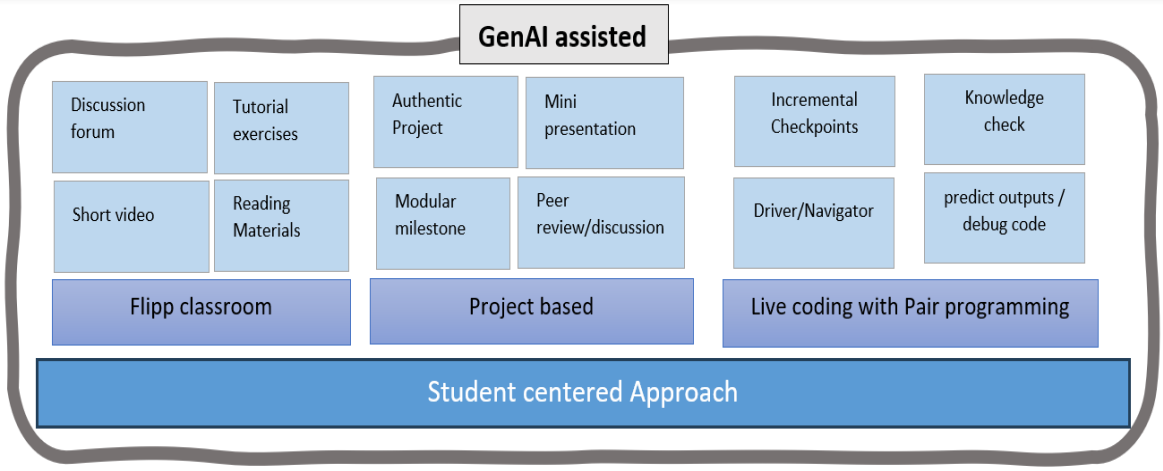


Fig. 3. Essential Components for Teaching Framework

3.6 Assessments

Assessments in programming courses should focus not only on code writing and correctness but also on problem solving processes, code optimization, testing and documentation practices. Well-designed assessments meet the course's learning outcomes and provide deeper learning, enhance critical thinking, and prepare students for the practical challenges of the industry [13]. GenAI technologies drive new professional transformation in programming, as software development industries demand new skills and experience to work with generative AI technologies. Therefore, it is critical to design assessments to cover the expected GenAI related skills in web programming such as web interface design, web database design and code generation. With the growing use of generative AI tools, some students may misuse these resources, increasing the risk of academic misconduct. To address this challenge, instructors should discuss AI with their students and consider revising their assessment designs. To reduce the risk of misconduct, instructors can rethink the types of assessments, break tasks into smaller components, provide sufficient time, ask for progress reports, and emphasize the process instead of the final product [21][22][23].

The assessment for our Web Programming course consists of two components: project coursework (60%) and a final exam (40%).

The coursework requires students to design and implement a website for a small business (such as car sales, real estate, or an online shop). The project is completed in groups of four students. Throughout the project, students must use GitHub as a collaboration and version control tool. This enables instructors to monitor the development process and track individual contributions. Assessment focuses on the development process as well as the final product. Each group is provided with a set of required system features, and every student is assigned responsibility for implementing a specific feature. Students must hold weekly meetings and submit meeting minutes along with progress reports. In addition, each group is required to deliver a live presentation demonstrating both the development process and the final product. This ensures that all group members have actively contributed to the project. Coursework project is broken down to three deliveries as follows:
Delivery 1 – Student generated website: students need to design and build website by using their learning knowledge from class. Students are not allowed to use AI tools and project must be entirely original and fully designed and developed by students.
Delivery 2 - GenAI-powered generated website: Students are allowed to use GenAI to build their website. By this way instructor makes sure that students have learned the GenAI related skills for designing web pages, database and generating codes.
Delivery 3 - AI powered platform for building websites: To keep students remaining up to date with current web technology in area of website development, students are required to investigate recent AI powered platform for website developments and present their findings through a live presentation.

3.7 Feedback and Survey

The structured feedback and survey results provide insight into how active learning strategies such as live coding, pair programming, and project-based learning impact student engagement and conceptual understanding. The findings can inform iterative course refinement and evidence-based instructional design. To evaluate the effectiveness of the implemented programming pedagogy, a feedback framework was employed. The feedback framework combines formative feedback, instructor feedback, and a post-course evaluation. Formative feedback was integrated throughout the course to support continuous improvement. The instructor feedback was used to assess depth of students' understanding and learning. A post evaluation was conducted to assess student perceptions of the teaching methodology. The evaluation included two separate surveys: one assessing students' perceptions of teaching effectiveness, and another investigating the reasons for students with a low-class attendance.

3.8 Conclusion

Programming education must adapt to both learning challenges and the growing impact of GenAI on software development. This paper introduced a redesigned web programming course that combines active learning methods such as flipped classrooms, live coding, pair programming, project-based learning, and authentic assessment with a GenAI-powered teaching framework. Rather than replacing foundational skills, GenAI is used to support critical thinking, reflection, collaboration, and evaluation of AI-generated code. The framework aims to strengthen core programming competencies while also developing industry-relevant AI skills, including prompt engineering, validation of AI outputs, and responsible AI use. Findings suggest that GenAI can improve engagement and learning when integrated thoughtfully within structured and reflective learning environments. The study highlights the importance of balancing strong programming foundations with AI-augmented development practices and positions GenAI as an opportunity to innovate programming pedagogy and curriculum design in higher education.

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Empowering Youth Leaders for Democratic and Inclusive Engagement: The ENGAGE Project's Online and International Training Courses

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Abstract

This article is a study based on the ENGAGE Youth project (Empowering Next Generation Advocates for Global Education), financed by the European Commission, Ref. no.: 2024-1-RO01-KA220-YOU-000250540. A group of youth and educational institutions from France, Czechia, Germany, and Romania are implementing the project. All of these organizations have rich experience with projects in Europe, youth development, human rights, and inclusion. The ENGAGE Youth project fills a need by providing an online course and training programmes for youth leaders (YLs) at both national and international levels. These programs focus on EU values, cultural diversity, inclusion, social justice, and civic participation. The project aims to equip youth leaders with the knowledge, skills, tools, and methods they need to include everyone and teach young people about democracy and European values. The article presents the courses developed within the project. The online course examines important topics such as EU values, intercultural dialogue, inclusion, social justice, leadership, digital citizenship, project management, impact assessment, motivation, and interconnection. The face-to-face international training session builds on the online course and further focuses on experiential learning, active participation, and co-creation. It aims to assess and refine the online course material, improving participants' skills in project design, impact evaluation, and youth engagement, with a strong focus on translating knowledge into tangible community actions. The article outlines the primary ideas derived from the findings of the international training course for youth leaders.

Keywords: *youth development, youth leaders, human rights, inclusion, international training, online course*

Context

The 73 million young people in Europe who are between the ages of 13 and 30 make up a significant part of the Europe's population and can influence its future [1]. However, 24.1% are at risk of poverty or social exclusion, with the Czech Republic having the lowest rate at 9.9% in 2024 (Eurostat) and Romania having the worst at 29.5% [1]. Additionally, studies show that younger generations lack a sense of belonging to the European Union since they typically tend to be less informed, active, and interested in democratic processes [2, 3, 4, 5]. Such views might seriously undermine democracy, particularly in light of the enormous challenges Europe is facing from the rise of alternative radical forms of participation and growing anti-democratic tendencies. Research shows that experiences of inclusion and exclusion are associated with civic engagement [6, 7, 8, 9, 10, 11]. Therefore, in order to prevent disengagement from the European project, we must continuously supply knowledge and useful settings in an inclusive and significant way. Promoting democratic principles and understanding, as well as including young people in democratic processes and decision-making, are important EU priorities. Information, authority and voice, power sharing, openness, accountability, and both material and non-material assistance are necessary for meaningful inclusive young civic engagement, underscoring the necessity of customized engagement tactics.

The ENGAGE Youth Project: Aims, Partnership, Target Groups and Results

The European ENGAGE Youth project (2024-1-RO01-KA220-YOU-000250540) aims at filling the gaps in today's youth development. It allows youth leaders (YL) to empower youth with real tools and inspiring activities that are based on European ideals, democratic processes, social justice and inclusiveness. It seeks to promote awareness of diversity and inclusion across Europe, by providing all youth, especially those at risk and those with impairments, equal access to opportunities. The overall impact of the project is positive societal change and the tackling of pressing social challenges [12].
The partnership is made up of NGOs with rich and fruitful experience in European projects, youth development, human rights and inclusion from France, Czech Republic, Germany and Romania.
The target group of the project is young people directly related to youth (youth leaders, youth workers and educators), those who can further disseminate the information (multipliers/facilitators), young people interested in the issues of the project and young people with fewer opportunities.
What sets the ENGAGE Youth project apart is its comprehensive and multi-dimensional approach, with research as the core pillar that drives all activities. This research influences the formation of knowledge and skills, the development of resources and the co-creation processes in international sessions. It also informs the development of useful exercises, discussions, feedback and awareness initiatives. Thanks to the wide and inclusive approach of the project, including theoretical, practical and digital tools, its results are impactful and transferably successful: the code of ethics, self-assessment tool, online course and international training session.

The Online Course

The online course responds to youth leaders' needs related to youth development as they were identified by a questionnaire conducted on an impressive number of participants. The insights revealed that the course should be structured as a flexible, blended programme that combines theoretical knowledge with practical exercises, case studies, and mentorship opportunities. The online course has 10 modules and 20 practical activities designed to actively engage youth in inclusive and democratic participation. The modules focus on topics identified as priorities by the research findings, including Europe and young people, social justice and equity, cultural identity, civics and leadership, project management, digital citizenship, diversity and inclusion, motivation strategies, gender, social, economic, and health, and impact evaluation. The platform is flexible and accessible, enabling youth leaders to continue their learning and professional growth at their own pace thanks to the platform, which also allows updates about best practices, concerns, and innovations in youth leadership, advocacy, and civic involvement. The online course includes multimedia content (videos, podcasts, images, etc.), quizzes or interactive exercises accommodating diverse learning styles, needs, and preferences. Moreover, its engaging and dynamic content can enhance youth leaders' motivation to have a significant impact on their communities and beyond.

Description of the International Training Session and its Future Developments

Building on the online course, the face-to-face international training session followed a non-formal education approach and further focused on experiential learning, active participation, and co-creation of knowledge. It aimed to assess and refine the online course material, improving participants' skills in project design, impact evaluation, and youth engagement, with a strong focus on translating knowledge into tangible community actions. The training programme for youth leaders (YLs) was designed as a practical, participatory and learning experience within the ENGAGE Youth project. The training promoted exchange of experiences and good practices among youth workers and engaged young people; it tested and experimented inclusive methods developed within the Engage Youth project to foster young people's civic engagement; it built and strengthened a European network of individuals and organisations working in youth work, non-formal education and active citizenship. The international training session focused on youth civic engagement and the inclusion of all young people, and took place in Oparenský Mlýn, Czech Republic, from 26 to 29 March 2026.
The target group consisted of youth work professionals and volunteers (youth workers, educators, teachers, association staff and volunteers) and young people engaged in associations, civic initiatives or civic service programmes; young activists and civil society actors interested in participation and inclusion issues. The training involved 25 participants sent from the partner organisations across Europe: Romania, Germany, Czech Republic and France.

It was developed in response to the needs of youth leaders and young people identified through an empirical questionnaire, which gave the programme a strong evidence-based foundation. Its main aim was to present the project to YLs and to test a selection of inclusive methods developed to foster young people's civic engagement, participation and active citizenship.
The ENGAGE Youth international session brought together YLs from project countries with different backgrounds, experience, and culture, to share best practices, tools and resources, thus enriching their experience, cultural awareness and understanding, promoting inclusion, tolerance, solidarity. Through interactive sessions, with colleagues from diverse cultural backgrounds and by examining various perspectives YLs learned to foster inclusive spaces, embrace diversity, and prevent and combat discrimination.
Participants gained invaluable insights into the ENGAGE methods that they could use effectively or adapt to their own contexts and how to apply these methods with their youths to increase inclusion, civic engagement and bring about positive social change (Table 1). What makes these methods useful is their inclusive, participatory nature and their ease of adaptation to different contexts. They assist YLs to create learning spaces through dialogue, cooperation, creativity and reflection, beyond traditional teaching. According to the youth leaders who attended the training sessions, these methods encouraged them to work as a team, be creative, listen actively, be aware of inclusion and diversity, plan projects, exchange experiences and prepare for action with young people.
The methods together can cultivate practical facilitation skills and a deeper ethical awareness. They help young people to learn about European values, to identify inequality, to communicate respectfully, to reflect on their experiences, to analyse community problems and to become more active citizens. This is why they are of particular importance in multicultural youth work where participation, inclusion and mutual understanding are essential.

Table 1.

Method	**Short description**	**Main objectives**	**Why it helps youth leaders**
EU in Action – Design Your Own diverse topics in a non-violent and constructive way. **EU Nation!**	This is a creative group activity where YLs explore European values, EU institutions and democratic processes by imagining and designing their "EU country." To explain complex concepts in an accessible way the method can include videos or visual materials.	To raise awareness of European values, active citizenship, democracy, participation and cooperation; to encourage creativity and teamwork.	It assists YLs in providing interesting and useful explanations of complex European subjects. The approach enables young people to learn through creativity, dialogue, and teamwork rather than merely presenting the EU through theory.
Art of Active Listening	A communication-based activity focused on respectful dialogue, listening, and empathy. It can be used to help participants discuss sensitive topics in a constructive and non-violent way.	To develop active listening, empathy, respectful communication, respect for different opinions and intercultural dialogue.	It provides youth leaders with a useful tool for facilitating group discussions, particularly when young people have diverse cultural backgrounds, experiences, or viewpoints. It encourages safer communication and lowers the risk of misunderstanding or conflict.
Understanding Equal Opportunities – A Sweet Life for Everyone	A role-play activity that places participants in diverse, two sided-coin positions. It helps them experience and reflect on exclusion, inequality, and access to opportunities.	To increase awareness of discrimination, inclusion, diversity and equal opportunities.	It helps youth leaders make abstract issues such as inequality or exclusion more concrete. As the activity can stir strong emotions, it also trains youth leaders how to manage sensitive topics carefully and responsibly.
Dixit Cards	A reflective method using image cards to help participants express feelings, impressions and learning	To support reflection, feedback, introspection and	It helps YLs create a safe and creative space for participation. The cards encourage young people to

	outcomes. It is especially useful when participants may find it difficult to speak directly.	emotional expression.	express thoughts, feelings indirectly, which can be useful in multicultural or multilingual context.
Problem Tree – Solution Tree	A structured group method where participants identify a community problem, explore its causes and effects, and then turn these into plausible solutions and actions.	To develop critical thinking, teamwork, project planning and community action.	It helps YLs guide young people from identifying a problem to figuring out realistic solutions. It is applicable, accessible and useful even for groups with no prior experience in project planning.
Waterdrop Interview	A reflective and evaluative method encouraging participants to share experiences and learning gains and to realise the value of their actions.	To support evaluation and recognition of learning impact.	It offers excellent opportunity for YLs to gather feedback and encourages young people to realise how important their participation can be.

Further Developments

Participants' international experience will be further enriched through, first of all, national cascade experiences and, then, interactive, "into-action" sessions with colleagues from diverse cultural backgrounds. In the first stage, YL will pilot the project proposed methods to verify their usability and impact. This stage will enhance YLs knowledge of the methods they can use, their abilities to apply them to their context and their leadership skills. This will boost their confidence in building trust and mobilizing community to tackle challenges and create social cohesion. The interactive, "into-action" sessions will encourage the exchange of ideas, best practices, and experiences among YLs and youths, internationally and nationally. This will ensure the practical and applicable part of the project. The international "into-action" sessions will also provide opportunities to establish partnerships with peers and organizations from Europe focused on promoting youth engagement and civic participation. Ultimately, the international action sessions may contribute to YLs engaging in their society and becoming successful agents of change, and in their turn enabling young people to become knowledgeable, alert, and involved citizens in society.

Evaluation of the Training Programme

The international training session took place in Oparnensky Mlyn, an old mill, which has roots back to the 16th century. The aim was to bring together YLs from project countries with different backgrounds, experience, and culture. The programme followed the same topics as the online course. The training session unfolded in an engaging and dynamic atmosphere stimulating communication, collaboration and creativity. Participants learned not only from trainers but also from each other by sharing positive experiences and valuable lessons. Examining the evalution methods can exemplify how creative and inspiring the training session was.
The first evaluation format was a formal evaluation, where the participants filled in a questionnaire (See Findings and Discussion). The second method (Figure 1) was a voting method: the participants had to vote with colored cards whether the aims for the ENGAGE international training session were achieved (green=yes, orange=maybe, red=no).

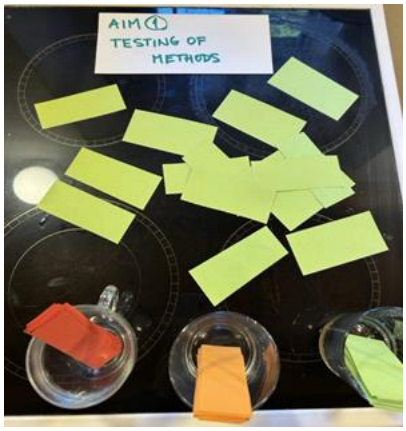


Fig. 1.

The “Sharing best practices, tools and resources” method (Figure 2) followed the same strategy. The high majority of participants thought that this aim was achieved.



Fig. 2.

The “target evaluation” method (Figure 3) allowed multiple categories to be evaluated anonymously. The participants had to make a dot with a pen for each criterion (organisation, content, trainers, atmosphere, venue, and food); the closer the dot was to the centre, the more satisfied they were with the category. The dots in the content appeared to be positioned slightly in the middle. The majority of the participants seemed to be pleased with the different categories. However, there were some issues, such as one participant being dissatified with the organisation and the venue was not being suitable for five participants.



Fig. 3.

The “Head-heart-hand” method (Figure 4) was a multifaceted method that asked participants to consider their experience through three lenses: head - what they learned, heart - what touched them or stirred their interest and finally hand - what they would do differently and what their suggestions were.



Fig. 4.

The course generally enjoyed appreciative feedback from participants. Participants showed their interest in learning new strategies and tactics for working with young people, such as innovative and creative approaches and techniques such as problem/solution trees, as well as strategies that are captivating and enjoyable for larger groups. They also emphasized that the course met their expectations related to their need for understanding diversity, developing active listening skills, and learning from other participants' professional experiences. Additionally, several youth leaders stated they improved their English language proficiency and communication strategies to use when working with young people.
The participants expressed their interest in the participatory activities, such as open-space conversations, games, and energizers, which they will definitely use to increase youth's engagement. The stories, experiences, openness and obvious enthusiasm they all shared touched everybody. The general positivity, the variety of perspectives on youth work, and the chance to network and gain knowledge from peers throughout the world were all encouraging.
The course was successful because it gave participants fresh perspectives on the work with young people and created an inspiring environment of excitement and sharing. The practical exercises and the vibrant idea sharing were the most valued features. Participants would welcome more in-depth training sessions in the future and are excited to put what they have learnt into practice. Overall, they liked the location and the venue. Their main points of criticism were that the seminar room was a bit small, that it had to be rearranged between sessions and meals, and that an additional space for sessions or informal time would have been beneficial.
To sum up, the participants learnt some new methods, were positively impacted by each other's motivation, optimism and ideas and wanted to adapt the methods to their target groups or take some advice and good practices to improve their youthwork. The participants were very happy about the contents of the training and the fact that they met other inspiring people. The flexibility of the programme and the organisators was really appreciated, and the nature close-by was a good occasion to explore other faces of the Czech Republic.

Findings and Discussion: Main Characteristics and Innovative Features

As most of the participants emphasised, one of the main characteristics of the programme is its strong non-formal education approach. The course combines ice-breakers, energisers, teamwork activities, role play, reflection tools, co-creation sessions and open-space discussions. Activities such as Power Tower and the Banana Song helped create group energy, trust and interaction, while methods such as EU in Action - Design Your Own EU Nation! Art of Active Listening, A Sweet Life for Everyone, Problem Tree - Solution Tree, and Waterdrop Interview supported deeper learning around European values, cultural identity, inclusion, project planning and impact evaluation.
The multicultural dimension of the training was also one of its key strengths. The session brought together 25 participants coming from diverse backgrounds, from partner organisations across Europe. This diversity created a rich learning environment in which participants could exchange experiences, compare youth work realities in different countries, and reflect on inclusion, diversity and active citizenship from multiple perspectives. The European character of the programme was reinforced through its focus on EU values, EU institutions, civic engagement and cooperation among organisations working in youth work, non-formal education and active citizenship.
A key innovative feature of the programme is that it does not only present theoretical content, but invites participants to test, adapt and evaluate practical methods that can later be used with young people. For example, participants were encouraged to choose which methods would be most suitable for their own groups and to reflect on why. The co-creation session, "From Learning to Action," also supported

participants in developing national plans to put the methods into practice with young people. This makes the course action-oriented and directly transferable to youth work settings.
The training also placed strong emphasis on co-creation and peer learning. Participants were not only asked to take part in activities, but also to reflect on how these methods could be used with their own groups. The session “Choosing the Method for My Group” encouraged participants to assess the relevance and adaptability of different tools for their local contexts. The “From Learning to Action” co-creation session further supported participants in developing plans in national groups for organising follow-up activities with young people. This approach transformed the training into a collaborative space where knowledge was jointly produced through exchange, experimentation and shared reflection.
The international training session was strongly participatory in both design and delivery. Rather than positioning participants as passive recipients of information, the programme invited them to test, adapt, discuss and evaluate the methods developed within the ENGAGE Youth project. Activities such as Power Tower, EU in Action - Design Your Own EU Nation! Art of Active Listening, Problem Tree – Solution Tree, and the Waterdrop Interview encouraged active involvement, teamwork, reflection and group problem-solving. This participatory structure allowed youth leaders and engaged young people to learn through experience, dialogue and practice, which is central to non-formal education.
The way the training session integrates European values and institutions with active listening, cultural identity, disability inclusion, equal opportunities, community action and impact evaluation is another innovative element. The participants appreciated the use of videos to define and clarify complex EU-related concepts as well as the creative tasks such as designing an EU country, which encouraged teamwork, imagination and active engagement.
Additionally, the programme also demonstrated the role of reflection and emotions in learning. Tools such as Dixit cards encouraged introspection and feedback, helping participants express their impressions and make sense of their learning experience. Role-play activities, especially those dealing with privilege and disadvantage, helped participants better understand exclusion, diversity and social inequalities, although the programme also recognises that such methods need careful facilitation because they can produce frustration or strong emotions.
As discussions revealed, participants attending such a course can gain several important benefits. They can strengthen their facilitation skills, improve their understanding of inclusion and diversity, learn new non-formal education methods, and become better prepared to support young people’s civic engagement. They can also develop stronger communication, teamwork, project planning and evaluation competences. At the same time, they benefit from international networking, peer learning and the opportunity to exchange project ideas and good practices with other youth leaders and organisations.
Practical transferability was another important characteristic. The training was designed not only to develop participants’ understanding, but also to equip them with concrete methods that could be applied in their own context. Activities such as Problem Tree - Solution Tree were considered clear, structured and usable even with participants who had limited prior knowledge, because they supported inclusion step by step in the thinking processes. This makes the programme particularly valuable for youth leaders who need adaptable tools for working with diverse groups of young people in different educational, civic and community settings.
Overall, the international training session can be understood as a participatory and multicultural learning space that combined non-formal education, peer exchange, co-creation, and practical experimentation. Its innovative value lies in the way it connected European values with inclusive youth work methods and transformed them into concrete tools for civic engagement. By attending the training, participants gained not only knowledge, but also confidence, methods, networks and practical strategies for supporting young people’s participation in diverse communities.

Conclusions

The international training session was both a pedagogical and practical activity. Thus, the participants in the international training session were able to use the training session as a hands-on learning engaging in various activities on inclusion and active citizenship as well as a training programme. The main value of the international training session was that it combined three different areas of education: non-formal education, multicultural and experiential exchange, and practical application of learning. The participants did not only gain an academic experience regarding European common value systems and civic engagement, but also gained exposure to experiential learning methods such as teamwork, role playing, reflectivity, peer learning and co-creating and therefore provided them with an opportunity to use that experience to assist them in the real-life application of their practices. Thus, the international

training session afforded the participants in this training session an opportunity to cultivate ways to adapt what they learned in the international training session back in their own communities. Another critical issue that the participants of the international training session gained from the training was the development of their competencies in facilitative roles aiming at supporting inclusive and democratic participation of youth. Through the training session, the participants developed tools to assist young people in being able to voice their thoughts and opinions, listening, working together, analysing problems, understanding diversity and taking action in their communities. In its entirety, the programme contributed to Youth Leaders' professional development and enhanced the overall quality of their work. This training programme's innovation does not result only from implementation of new techniques, but also from combining multiple techniques into one coherent learning pathway that includes: European Values, Inclusion, Cultural Identity, Disability Awareness, Project Management, Impact Measurement, and Community Action. It provides participants with opportunities to co-create knowledge with others in addition to actively engaging in the learning process.

There are some limitations with the programme, such as requiring longer time periods for certain reflective activities and careful management needed for activities using techniques such as Open Space and Role Play so that all participants could understand the process and feel comfortable. Despite these limitations, the programme represents a strong model for training youth leaders generally, as it develops competencies in professional practice, encourages democratic participation and supports development of inclusive environments for Youth Work throughout Europe.

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Gamification in Cybersecurity Education and the Enhancement of Professional Skills. Insights from the Cyber Sapere Initiative in Italian Higher Education Institutions

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Abstract

The rapid evolution of cyber threats and the increasing number of security incidents targeting academic environments have emphasized the need to strengthen cybersecurity education in higher education institutions (HEIs) [1], [2]. Universities are not only responsible for preparing future cybersecurity professionals but also for ensuring that students, researchers, and administrative staff develop adequate awareness and skills to mitigate cyber risks. In this context, gamification is gaining attention as an innovative educational approach capable of improving learning effectiveness and supporting the development of a stronger cyber posture within academic institutions [3]. The need for cyber training has also been reaffirmed by recent European regulations on the topic such as Network and Information System Security. This paper explores the role of gamification in cybersecurity education and examines how game-based learning strategies can contribute to both student training and the upskilling and reskilling of institutional personnel [4]. Typical gamification elements, such as interactive learning, simulations of real cyber-attack scenarios, challenges, and reward systems, transform traditional learning processes into experiential activities where participants can actively apply theoretical knowledge and test different strategies in a safe and controlled sandbox environment [5],[6]. Given the dynamic nature of cybersecurity threats, the relevance of this approach is particularly significant in the context of continuous professional development, where organizations need to invest in professional development and reskilling initiatives. Within this context, the study focuses on the Italian Ministry of University and Research initiative known as the Cyber Sapere program, which contributes to the implementation of the National Cybersecurity Strategy [7]. The program promotes the transfer of cybersecurity knowledge, specialized training courses, and expert consultancy to higher education institutions. Its objective is to strengthen institutional resilience by fostering a systemic approach to cybersecurity education that involves students, researchers, and academic staff. Drawing on the experience of the Ministry of University and Research, this paper proposes a replicable and measurable best-practice model that can support policymakers, academic communities, and industry stakeholders in strengthening cyber resilience, promoting a culture of secure innovation, and enhancing digital skills across the research ecosystem.

Keywords: *Gamification, cybersecurity, education, upskilling, reskilling*

1. Introduction

Public and private institutions today face a landscape of growing exposure to cyber threats. The open nature of academic ecosystems, combined with a diverse user base and the strong interconnection between research, teaching, and administrative activities, makes Higher Education Institutions (HEIs) particularly vulnerable [1], [2]. Targeted attacks against academia have increased in recent years, highlighting vulnerabilities that are not exclusively technological but also involve the behaviors of individuals and organizational shortcomings. In this context, cybersecurity training becomes essential. Academia is not only responsible for preparing future cybersecurity professionals, but must also ensure that students, researchers, and administrative and technical staff adopt behaviors appropriate to managing cyber risk. However, traditional training models are often passive, comprising lectures and static e-learning modules, and show clear limitations in their ability to produce lasting behavioral change. In light of these weaknesses, gamification is becoming increasingly more established as an innovative approach in the field of education. Integrating game design elements into educational contexts turns learning into a more active and engaging process, encouraging user participation and interaction [3]. In

the field of cybersecurity, this translates into the ability to simulate realistic scenarios, allowing participants to test decisions and strategies in controlled environments through the use of learning platforms that also leverage Artificial Intelligence [4]. At the same time, digital transformation and evolving security frameworks are redefining competency requirements in academic research. Therefore, it is becoming necessary to promote structured upskilling and reskilling courses to face changing professional needs [5], [6].
Within this context, this study examines the "Cyber Sapere" initiative, promoted by the Italian Ministry of Universities and Research. The objective is to assess how much more effective gamified approaches are compared to traditional models in promoting behavioral change, contributing to skills development, and supporting the alignment of academic institutions with national and European cybersecurity strategies. Therefore, this paper aims to offer a systematic analysis and empirical evidence on a model that could potentially be replicated in complex settings.

2. Literature Review

Recent literature highlights how academic institutions are increasingly adopting structured frameworks for managing cybersecurity, often inspired by international standards and European guidelines [5]. However, these frameworks tend to focus on technology and institutional procedures, neglecting the human element, which represents one of the primary risk factors. This imbalance is part of the reason why, despite the adoption of advanced policies and tools, many organizations continue to experience vulnerabilities related to user behavior.
In this context, gamification emerges as a possible tool for addressing these limitations [2]. Established research shows that introducing interactive digital learning platforms into training can increase user engagement and motivation, encouraging more active participation [3], [7]. In cybersecurity, incorporating simulations, challenges, and interactive scenarios into training programs brings learning closer to real-world situations, helping participants develop practical skills more effectively. Despite this, traditional awareness programs remain widespread in academic institutions, and while they help educate participants, they often prove ineffective at changing user behavior in practice, particularly in the medium and long term. The literature highlights a persistent gap between theoretical knowledge and practical application, which represents one of the main weaknesses in cybersecurity management [8], [9]. At the same time, the development of digital skills is becoming increasingly important. The gap between the supply and demand for cybersecurity skills and STEM competencies in general is now widely acknowledged at the European level, prompting organizations to commit to continuous investment in training strategies. In this context, innovative approaches such as game-based learning can offer more flexible and adaptive solutions, capable of supporting tailored learning experiences [5], [6]. While gamification has attracted considerable attention in recent years, the literature still presents some significant gaps. In particular, empirical evidence on the long-term effectiveness of gamification remains limited, and models that integrate training, regulatory requirements, and organizational practices are still underdeveloped. Furthermore, no clear operational models have yet emerged that can be replicated in complex academic settings. This study aims to address these gaps through a systematic analysis of the "Cyber Sapere" case, both at the ministerial level and within individual universities and Higher Education Institutions (HEIs).

3. Methodology

This study aims to integrate quantitative and qualitative evidence to assess the effectiveness of the "Cyber Sapere" program. This approach makes it possible to document all measurable data regarding participation and user performance, as well as qualitative elements, such as the way the training experience is perceived by participants and any changes in their behavior [6].
The research data were collected during the implementation of the program across several Italian Higher Education Institutions and the Ministry of Universities and Research. The participating institutions vary considerably in size, digital maturity, and organizational model, providing a range of contexts in which to evaluate the program. Data sources include metrics generated by the training platform, results from gamified activities, satisfaction surveys distributed to participants, and qualitative feedback gathered through direct interactions with them. The analytical framework was built around three main factors: behavior — focusing on levels of engagement, knowledge retention, and the ability of users to develop safer habits; skills development — aiming to assess the extent to which the program contributes to upskilling and reskilling, both in terms of technical skills and broader competencies; strategic alignment

and replicability of the model — focusing on consistency with European regulatory frameworks and the potential for adaptation across different organizational contexts.
The assessment of the program's effectiveness draws on an integrated set of indicators. Analysis of baseline data helps direct training toward institutions with the greatest need to improve their security posture and expand employee competencies, while data regarding the participants' performance in simulations allows for an assessment of their ability to apply skills in realistic scenarios. At the same time, qualitative analysis of feedback provides a complementary perspective, useful for understanding the impact of the training experience at both an organizational and cultural level.

4. Case Study: The “Cyber Sapere" Program

The "Cyber Sapere" program was developed by the Ministry of Universities and Research (MUR) in collaboration with the National Cybersecurity Agency (ACN), as part of the National Cybersecurity Strategy 2022–2026 [10]. The program is a joint cybersecurity initiative aimed at universities, Higher Education Institutions for Fine Arts, Music, and Dance (AFAM), and the MUR. The objective is to promote a culture of cybersecurity, enhance the digital skills of users, strengthen their security posture, and contribute to the overall resilience of the national academic system. The program is structured around three distinct areas. The first is training, which aims to improve the basic cybersecurity skills of students and staff at MUR, universities, and AFAM institutions through e-learning courses, instructional materials, training programs, and on-site workshops. This need is grounded in the awareness that basic cybersecurity skills — and STEM competencies in general — are of primary importance and require sustained investment. This is further supported by the literature, which highlights a significant skills gap in the Italian labor market [11].
The second area is prevention, aimed at strengthening the ability of staff at the Ministry, universities, and AFAM institutions to identify and counter cyber threats through hands-on exercises in the form of simulated phishing campaigns. The third area is analysis and monitoring. The initiative aims to establish a structured and ongoing framework of training and operational activities focused on analyzing and monitoring MUR assets, ensuring an accurate and up-to-date assessment of risks associated with applications in use.
Prior to the training, a skills assessment was conducted to identify the needs of the staff at the Ministry, universities, and AFAM institutions, measuring their average level of cybersecurity preparedness [6]. The results set the guidelines for the training plan, helping to identify content and topics aligned with the actual needs of the intended participants. The table below summarizes the results of the cybersecurity skills assessment questionnaire.

Table 1. Key results of the cybersecurity skills assessment questionnaire

Type of entity	Entities involved	Users involve	Certificates issued	Awareness level
Universities	103	11.413	14/25	Intermediate
AFAM	129	1.299	14/25	Intermediate
Ministry	1	141	13/25	Intermediate
Totals & Media	233	12.853	14/25	Intermediate

The program offers two complementary training formats: e-learning courses and in-person classes. In both cases, participants were required to complete a skills assessment test and a satisfaction survey at the end of each course.

4.1 E-learning Training Courses

The first format consisted of both synchronous and asynchronous e-learning sessions. Synchronous e-learning sessions took place on Microsoft Teams, open to a large group of users specifically selected by each institution and the MUR. Given the large number of participants, interaction was limited to the chat function, with responses provided by the instructor. The course totaled 32 hours, divided into 8 sessions of 4 hours each. The table below presents the key KPIs for the synchronous e-learning courses, including user satisfaction scores.

Table 2. Key KPIs for synchronous e-learning training courses

Type of entity	Entities involved	Users involve	Certificates issue	Satisfaction questionnaires	User satisfaction
Universities AFAM	100 148	1.151 781	974 435	426	3.52 / 5.00
Ministry	1	38	35	24	3.83 / 5.00
Totals & Media	249	1.969	1.444	450	3.54 / 5.00

Asynchronous e-learning sessions were reserved for MUR staff only, with the course being conducted on CyberGuru, an e-learning platform built around a multimedia micro-learning approach. The course was structured into modules organized with increasing difficulty to support the gradual development of skills and ensure participants stay current with evolving cyber threats. The course totaled 27 hours. The table below presents the key KPIs for the asynchronous e-learning courses, including user satisfaction scores at the time of writing.

Table 3. Key KPIs for asynchronous e-learning training courses

Type of entity	Entities involved	Users involved	Certificates issue	Satisfaction questionnaires	User satisfaction
Ministry	1	390	264	59	4.49

4.2 In-person Classes

During in-person training sessions, the "Cyber Sapere" program adopted an innovative method based on the principles of edugaming — a tool for active learning. Each session begins with a preliminary phase in which major cyber threats are contextualized through an analysis of data drawn from operational arrangements provided by the National Cybersecurity Agency [9], with specific concern for the field of education.

Participants are then directly involved in a structured competition covering important cybersecurity topics, designed to stimulate learning through gamification. Specifically, participants are asked to use the Kahoot! platform to answer a series of questions on the topic. Individual performance is assessed on the basis of two criteria: the accuracy of answers and the speed of completion.

Following each question, the topics covered in the test are explored further through multimedia materials and micro-lessons delivered by qualified instructors to consolidate the knowledge acquired while encouraging critical reflection on the subjects.

Finally, to recognize and reward the top performers, the three participants with the highest rankings receive prizes in the form of promotional materials and branded merchandise provided by the program organizers.

This approach was adopted to encourage active participation and greater engagement, based on the premise that game-based learning can offer advantages over conventional teaching methods [12].

At the time of writing, 11 in-person training events have been held at the Ministry, universities, and AFAM institutions, each lasting 2 hours. The table below presents the key results of the in-person training courses, while subsequent tables provide a breakdown by institution for courses held at specific universities and AFAM institutions, organized by geographic area (North, Central, and South Italy).

Table 4. Key KPIs for in-person training courses

Type of entity	Entities involved	Users involved	Certificates issue	Satisfaction questionnaire	User satisfaction
Universities AFAM Ministry	8 2 1	235 30 39	235 30 39	212 30 37	4.60 / 5.00 4.88 / 5.00 4.28 / 5.00
Totals & Media	12	272	272	192	4.58/ 5.00

Table 5. Key KPIs for in-person training courses at universities (by geographic area)

University	Users involved	Satisfaction questionnaire	User satisfaction
Universities in Central Italy	40	-	-
Universities in Northern Italy	35	-	-
Universities in Northern Italy	23	23	4.54 / 5.00
Universities in Southern Italy	23	23	4.69 / 5.00
Universities in Northern Italy	17	17	4.37 / 5.00
Universities in Southern Italy	35	35	4.48 / 5.00
Universities in Central Italy	38	38	4.61 / 5.00
Universities in Central Italy	80	77	4.69 / 5.00
Totals & Media	272	212	4.60 / 5.00

Table 6. Key KPIs for in-person training courses at AFAM institutions (by geographic area)

AFAM	Users involved	Satisfaction questionnaire	User satisfaction
AFAM Institutions in Southern Italy	20	20	4.86 / 5.00
AFAM Institutions in Northern Italy	10	10	4.90 / 5.00
Totals & Media	30	30	4.88 / 5.00

5. Discussion

A detailed analysis of user satisfaction data across the three training formats tested within the "Cyber Sapere" program — synchronous e-learning, asynchronous e-learning, and in-person sessions structured around edugaming concepts — shows that participants clearly favor in-person training experiences featuring interactive game-based dynamics. In particular, the in-person edugaming format achieved an overall user satisfaction score[1] of 4.54 out of 5, approximately 30% higher than the 3.54 out of 5 scored by the synchronous e-learning course, and 2% higher than the 4.49 out of 5 scored by the asynchronous e-learning course.
Based on data from all three course types, the results are illustrated in the diagram below.

[1]The satisfaction score for each course was calculated as a weighted average of the ratings received and the number of completed questionnaires.

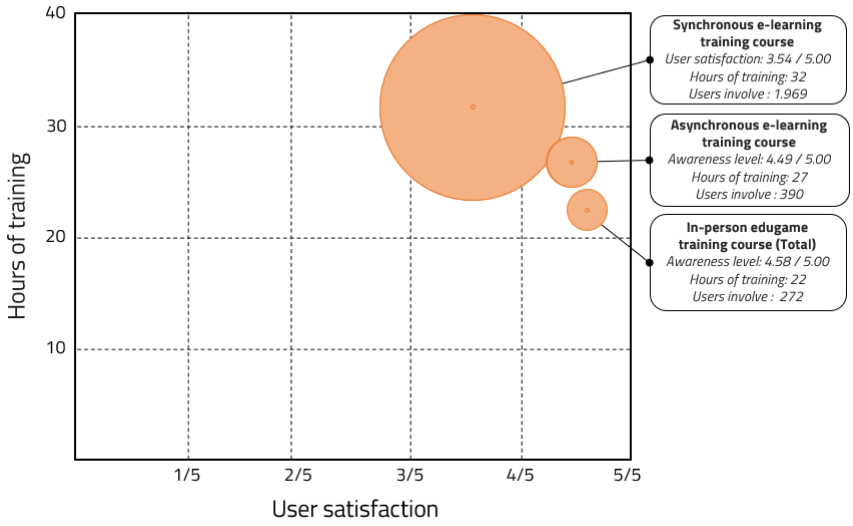


Fig. 1. Relationship between course satisfaction levels, number of training hours, and number of users involved across the training formats of the "Cyber Sapere" program

The chart illustrates the relationship between three key variables: course satisfaction levels, number of training hours, and number of users involved — the latter represented by bubble size. Specifically, the size of each bubble is proportional to the number of participants trained. The distribution of points on the chart also allows for a joint interpretation of training volume and perceived learning effectiveness. Points in the upper right area represent situations marked by a high number of training hours combined with higher satisfaction levels. In summary, the best results are represented by the largest bubbles in the upper right area, as they simultaneously reflect broad participation, intensive training activity, and a positive assessment of the learning experience.

The quantitative results show that edugaming-based teaching methods foster a stronger perception of learning effectiveness. This finding is consistent with the literature on experiential learning and gamification, which suggests that incorporating game-based elements into educational contexts can stimulate intrinsic motivation, facilitate the understanding of complex concepts, and encourage active participation [12].

By contrast, e-learning formats — while offering significant advantages in terms of flexibility, accessibility, and scalability — appear to generate lower levels of perceived satisfaction in the context analyzed. In particular, asynchronous sessions, while useful for independent learning, are less effective at supporting interaction and peer exchange, whereas synchronous sessions allow for real-time interaction but fall short of fully replicating the experiential and immersive quality of in-person activities. Interactions with participants and institutional leadership where in-person training took place revealed a significant level of interest in the adopted edugaming method. This was further reflected in the willingness expressed by institutions to plan future training initiatives based on the same approach. Overall, these findings appear to support the hypothesis that users prefer an edugaming format.

6. Conclusion

It should be noted that this study was conducted on a purposive and diverse sample of academic institutions and organizations. While not fully representative of the entire academic landscape, the sample of training participants is statistically significant, both in terms of the number of institutions involved and the number of participants. The academic background shared by participants helps contain intra-sample variability, strengthening the internal validity of the analysis and improving the reliability of the empirical findings. In particular, the consistency of the professional profiles of the participants facilitates data normalization, reducing the incidence of confounding factors and increasing the overall robustness of the results.

Overall, user satisfaction data suggest that integrating innovative teaching methods based on edutainment and gamification, tested in in-person training contexts, may represent a key factor in improving the perceived effectiveness of training programs. These findings support the adoption of

hybrid teaching models in which the digital component is complemented and enhanced by immersive and interactive experiences, aiming to maximize learning outcomes and user satisfaction.
Despite clear empirical evidence of a higher level of satisfaction with edugaming-based solutions among training participants, the "Cyber Sapere" program initially chose to reserve this approach exclusively for in-person activities. On the one hand, this choice fosters closer interaction between participants and instructors with positive effects on learning and teaching dynamics; on the other hand, it introduces a significant scalability limitation, as it reduces both the number of course hours and the number of participants that can be reached. While this choice is entirely sustainable, this constraint could become particularly relevant if the initiative were to be expanded with the goal of extending the training offering to a broader audience or making the format replicable in non-academic settings as well.
A further relevant aspect in assessing the effectiveness of edugaming solutions and training programs in general concerns whether the learning experience can generate significant and lasting changes in organizational culture and individual behavior, but measuring the impact of specialized training courses on the overall security posture of the academic system — one of the program's strategic objectives — is particularly complex. This is due to the highly dynamic nature of cyber threats and the limited size of the participant sample. This complexity reflects the inherent limitations of training impact assessment models [13] and the evaluation of return on investment (ROI) [14]. In particular, assessing the effects on organizational behavior and, above all, on systemic outcomes presents significant challenges, especially in complex and constantly evolving contexts such as cybersecurity. While it is reasonable to assume that individual training sessions produce positive effects on participants, it is equally clear that a systemic and ongoing approach to training is necessary. Therefore, it is essential to ensure that training is consistent, widespread, and sustained over time, reaching all members of the academic community — including administrative and technical staff, faculty, and leadership — in order to bring about structural change in security culture and organizational behavior.
As the program's implementation period draws to a close, and in light of the analysis of further training activities planned within the "Cyber Sapere" initiative, it seems appropriate to consider introducing additional measures to complement those already implemented. In particular, the adoption of e-learning edugaming solutions could be considered, with the goal of expanding the participant base while maintaining an adequate level of immersiveness. This approach would combine the benefits of edugaming in terms of engagement and interactivity with greater scalability and accessibility, while also expanding the content beyond basic training to include highly specialized courses.
A further area of intervention concerns the introduction of a cyclical assessment process to measure progress in security posture, building on the initial assessment conducted as part of the initiative. This activity should be conducted according to a structured methodology framework to ensure the consistency, replicability, and reliability of results.
Finally, it is proposed that training activities be supported by systematic awareness-raising initiatives aimed at engaging the main representatives of academia. The objective is to promote greater awareness of the importance of continuous, widespread, and pervasive cybersecurity training, in line with the strategic goals of the program.

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Using AI in Creating Visual Materials for a Course in British Culture and Civilization

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Abstract

The purpose of this paper is to analyse the benefits of using artificial intelligence tools such as Chat GPT in order to create, based on a given material and on given instructions, visual materials such as collages for a course in British Culture and Civilization. This course has been taught by the author of the present paper during the academic year 2025-2026, second semester, to second year BA level students specialized in Translation and Interpretation, having English as a main foreign language. The course curricula was designed by the author of the present paper to be built around the way in which various historical references from the past of British culture and civilization are still relevant today. As we walk throughout cities and rural areas, and as we look at landscapes throughout the territory of the UK, we can see various details that can be explained based on the history of the UK, starting from names of London boroughs, which take us to the ancient Roman past of these areas, and ending up with 18th and 19th century Great Britain, which were the main time periods when modern society as we know it today began, based on various important institutions such as tea and coffee houses. The author of the present paper has used her class materials and her prompts to create, for the last courses, collages in order to illustrate for students various topics, starting from the UK shopping malls, types of houses in London, and moving on to influence of the 18th-19th century UK institutions, and typical British stories such as mystery and detective stories. We know that visual materials may have a high impact since we rely most of all on the visual sense in order to understand the world and get our information about the outside world. The methodological framework is made up of teaching techniques, visual impact, cultural awareness and psychology.

Keywords: *Psychology, visual sense, cultural empathy, cultural awareness*

1. Introduction

Using AI as a tool to help us in our work has already become a current practice nowadays. Of course, we need to distinguish between ethical and non-ethical ways of using AI in our activities, ranging from students' work to researchers' work, as well as from looking for information regarding how to organize a trip, or how to redesign our home interior, to using AI agents in order to help in putting posts on online social media regularly, using our knowledge and our written communication style. AI can be used to a widely accepted extent when we need to do work fast, such as when working with data and sorting out through information, or when sending emails and creating suitable message faster than we would do if we were to compose each and every email. When we speak about doing our own work, we need to be cautious as to what extent we can use AI, so that we do not have entire sets of homework and papers written by AI in our place.

AI can bring the past to life, if we consider how we can take photographs and information from the past, and ask AI to create pictures for us, reconstructing certain places and animating certain scenes, such as those from old, historical areas and houses in cities. Plenty of visual materials can be created with the help of AI, starting from images and posters with both images and information, to sketches and progress of history of cultures, as well as posters with presenting certain topics and issues, together with the conclusions if we take into account teaching a course in British Culture and Civilization.

The present paper focuses on the way in which Chat GPT was used to create a series of visual materials for some of the courses of lectures for a course in British Culture and Civilization taught by the author of the present paper during the second semester of the academic year 2025-2026, to students in the Translation and Interpretation Specialization at the Technical University of Civil

Engineering, the Faculty of Engineering in Foreign Languages, Department of Foreign Languages and Communication. The author of the present paper has created a curricula for this course of lectures starting from references to the past which are still around in British society and which make up their common context of everyday life discussions, and which needs to be understood starting from the historical episodes and personalities by members outside British culture. British culture is made up of a series of references which can be traced to the past or to various ideas about how the British culture and identity can be portrayed in order to be unique and immediately recognizable due to its specific features. Starting from the questions: Where can we find the British spirit nowadays? What is uniquely and typically British? What are values typical for the British? we can go through mainstream and popular culture elements, as well as through the history of British culture. As examples, we can consider how tv shows such as Doctor Who (which ran from 1963 to the present) presents us with a typical British lord, even if he is shown in a science fiction setting, where he travels in space and time. What matters is his attitude. Another tv show, Downtown Abbey (2010-2015), presents us with the lives of a typically British aristocratic family and their servants during the early 20th century, showing us their typical lifestyle and behaviour. British humour is present in Monty Python's Flying Circus (1969–1974), where we see dry humour, as well as absurd situations. In addition, outsiders can associate British culture with typical British heroes and characters, such as James Bond, Sherlock Holmes, Robin Hood, the latter being used metaphorically in debates about taxes and redistribution. We can also think about personalities with strong associations with British culture, such as William Shakespeare. Writers such as George Orwell, through their work, are references in debates dealing with topics such as free speech, surveillance, and speaking and revealing the truth in the political world. Contemporary characters such as Harry Potter and stories in this series make references to boarding school nostalgia, which is specific to members of British culture and part of their everyday life, common reality. In this way, a course in British Culture and Civilization can set up and trace some important landmarks for Romanian students in order to be able to adapt to the British society and to understand their common universe of references. They may be familiar with everyday life rituals and practices, such as the 5 o'clock tea, using the weather as a topic for small talk, queuing as a sign of discipline, respect, and politeness, pub culture, where socializing takes place, famous foods such as fish and chips. They may also be familiar with British attitudes such as emotional restraint, which is expressed in the idea of the "stiff upper lip," as well as to their saying "sorry" very frequently, and with their use of self-deprecation, irony, and understatement (e.g. saying "not bad" instead of "very good"). They may also be familiar with the importance of monarchy and constitutional tradition and they may know some of the historical events and personalities. At the same time, they need to be prompted to take a deeper, more analytical look, at British culture and society, and to understand that the British monarchy stands for continuity, unity, as well as for national identity, that the Magna Carta represents a foundation of liberty and of the rule of law, that Winston Churchill is a symbol of leadership, national resilience and wartime unity, who is frequently used as a historical reference in relation to these ideas in contemporary political speeches, that Margaret Thatcher is referred to in debates about free markets, privatization, as well as national sovereignty, that the World War II is a symbol of endurance and collective sacrifice, often referred to as "The Blitz Spirit," that the Industrial Revolution is used as a reference to innovation and economic transformation in discussions on this topic. In addition, this course raises awareness to the still existing talk in British society about class and social structure, in relation to accent – where we see the division between Received pronunciation, or RP English, associated with the upper and upper middle classes vs the regional accents, such as Scouse, Geordie, and Brummie for the working class - , and to education – where we see the division between public and private schools and universities, between Oxford and Cambridge for the elites vs other universities. Values that are part of the British culture and identity are also mentioned in the course of lectures, e.g. fair play, common sense, the rule of law, tolerance, liberty. The slogan *Keep calm and carry on* from World War II is revived in present-day talk in British society, and it refers to British emotional restraint and composure. The specific type of British communication is also presented, which is indirect and which means that it focuses on avoiding conflicts. Avoiding conflicts is also signalled based on the use of humour as an emotional buffer. Historical landmarks of Great Britain, such as the Roman period and other influences are presented based on the names of the London boroughs, whose etymology reveals the way in which various areas that are now urban were rural in the past. The course of lectures also underlines the key time periods in the historical development not just of British society, but of societies all over the world: the 18th century and the Victorian Age. During these ages, societies as we know them today have begun to take shape. The 18th century brought tea and coffee houses into social and intellectual life, with intellectual debates available, democratically, for all social classes. The Victorian Age gave the start to the Industrial Revolution and to the possibility

of social mobility, as well as to the prevalence of life in urban areas.
With the last courses of lectures, the teacher decided to prompt students to see how previous knowledge gained in the beginning courses can be applied to various British cultural products, and also to look at various aspects in present British society, and of life in contemporary Great Britain based on their significance from the past, by using visual materials created with the help of Chat GPT.

2. Materials and Methods

A course in British Culture and Civilization wishes to make students feel a sense of cultural empathy with the members of British society. The historical aspects are part of the background knowledge which they should have in common with the members of the contemporary British society, in order to better relate to them and not to feel left out. After setting up the basis, with historical references and their relation to the present-day world, with the values and communication style of British culture, with national traits the British themselves consider to belong to them, this course of lecture continues with presenting students with ways in which they can relate to the British culture members, starting with cultural products which originate in British culture but which were afterwards influential in all other cultures, and which are certain stories and genres of stories. Fiction serves as a well-known way to build and develop empathy skills for readers, and British fiction is no exception. One of the courses of lectures focused on mystery and crime fiction, which could be traced back to the Victorian-age penny dreadfuls, which were cheap serial publication, costing one penny, about exciting and thrilling happenings. The material created with the help of Chat GPT based on prompts and additional details along the process was the following one, shown in Fig. 1 below:

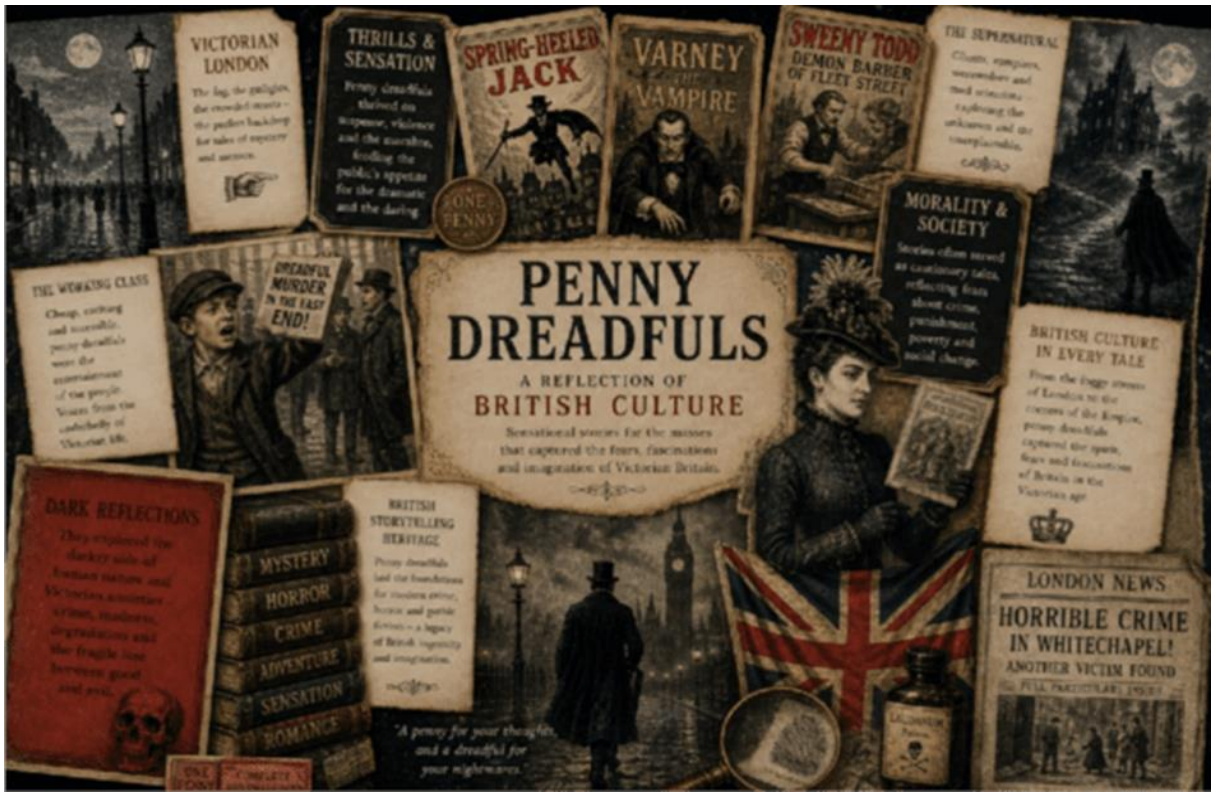


Fig.1. Victorian Penny Dreadfuls

The visual material in Fig. 1 raises the students' awareness to the context of Victorian London, to the aspect of its street, to its working class, to the issues worrying the Victorians and making them fear at the time, which were all present in the Victorian dreadfuls, as well as to the features included in these stories, e.g. horror, adventure, romance, mystery, crime, sensation, etc. A newspaper headline about a crime committed during these times shows how these stories reflected issues present during Victorian society. Most of all, this visual material prompts students to think and to understand how Penny Dreadfuls were a reflection of British culture, making them understand them by relying on their notions of history regarding the Victorian Age. The Victorian Age – or, at least, some of its aspects, come to life once they are explored based on such stories.

Victorian and Edwardian ghost stories could also be traced as the source of contemporary-day mystery, thriller, suspense, and crime stories, full of unexpected plot twists, just like the Victorian penny dreadfuls. These stories contain the main ingredients of novels and stories that remain successful to these days. The penny dreadfuls contained plenty of examples of anti-heroes, fighting for justice in society, while the Victorian and Edwardian ghost stories included plenty of fantasy elements, and they made reference to the aristocratic mansions with all of their secrets and mysteries from the past. Fig. 2 below tries to help students enter the atmosphere of Victorian and Edwardian ghost stories, to consider some famous titles, as well as to create a picture of the living society of the times, not based on historical dates and mainstream events, but based on everyday life:



Fig. 2. Victorian and Edwardian Ghost Stories

In addition, the lecture discussed novels by Agatha Christie, which are still enjoyed nowadays by readers from all over the world, and which present us with typical, emotionally restrained British cultures, speaking RP English, and with detective relying on reason and logic in solving various crimes, who once again seem typically British. The novels by Agatha Christie prompt readers to consider the origins of their own perception about members of British culture as very polite, emotionally restrained, and also using indirect communication and dry humour. From the previous stories, which were based on ghost hauntings, irrational mysteries with irrational explanations, with a loss of contact with reason and down-to-earth reality, we reach with the stories of Agatha Christie a highly down-to-earth British society, whose members rely strongly on reason and where everything is reduced to rational explanations. By the end of the stories, everything has been explained based on reason, and we have realized that everything can have a logical explanation. A complete picture of British cultural life and society is presented in the novels by Agatha Christie, if we look at the visual material proposed for this part of the lecture, in Fig. 3. We can find typical British settings, references to pubs and social life, reflections of typical British values, class and society, the British weather, manners, a sense of fair-play, as well as scenes related to travel where the railways are present, which were part of the society of those times, making modern life possible and comfortable. The novels by Agatha Christie are so familiar to all of us, that we may notice how we may have not been aware that they belong to a culture different than our own. We have all been transposed into the stories and felt in a very familiar world.



Fig. 3. British Culture in Agatha Christie's novels

UK malls, part of everyday current life, are illustrated in Fig. 4 below:



Fig. 4. UK malls.

Students understand how the UK prefers a shopping area in the city where people can walk or use public transport and not rely on cars, which makes them different from US malls which rely mostly on personal cars for transport. There are also famous UK shopping centres and historical shops, which show students that the history of the place remains an important part of British identity.
Types of houses in the UK (shown in Fig. 5 below) allow students to experience a sense of specificity tied to place:



Fig. 5. Types of houses in the UK.

They are introduced to the current visual aspect of UK life, and are also presented with how London apartments are very small. They are so small because of high demand of property and high property prices, as well as since London was built for terraced houses, not big appartments in Georgian and Victorian times, and also since the destruction of large city areas by bombings in World War II led to housing shortages after the war.
The course of lecture relied on visual materials, which are frequently used for the learning of English as a foreign language [1] – and this course in culture and civilization also helps students develop their foreign languages skills. While the learning of any topic is made easier based on visual materials, these materials can be considered the most natural way of learning for us, since we human beings rely on our visual sense more than on the others in order to gain our knowledge about the surrounding, external world [2]. Teaching this course with visual materials should make learning effortless, or as effortless and natural as possible, since students are used to gain their information about the surrounding world in this way in everyday life contexts. The course was designed as a trip in time and space, through the main timelines and aspects of British culture and society. It was intended to help them adapt to life in contemporary British society, since they may have the opportunity to study or even work there in the future, not just to simply visit Great Britain as tourists. When we adapt to a place, we need to consider both mentalities and the visual aspect of the places. We are aware that the small size of London apartments can be uncomfortable in the long term for someone coming from another culture. The unfamiliarity of a place, both regarding its visual aspect and habits, as well as unfamiliar references of the members of the respective culture, can lead to us experiencing culture shock, which can make us

not accept the cultural differences, feel uncomfortable, and not be able to function properly in the respective environment, e.g. at school or at work [3]. A course in culture and civilization can help prevent such situations, through building up background knowledge and through establishing cultural empathy [4] with members of another culture.
Such materials can be created manually by the teacher or by using tools such as various programs (e.g. Photoshop) as well, not just by using AI to generate these collages. The advantage of using AI to create these visual materials lies, however, in the fast pace within which they can be made available, as well as in the way in which teachers without any expertise in creating such material manually, themselves, or by using specialized programs like Photoshop can create visual materials with a highly professional look. AI can become a tool or a partner for teacher wishing to improve the visual aspect of the materials they use for class. Unlike a human partner, AI can take the minimal amount of time to help teachers create visual materials that can amaze everyone. If teachers use AI programs such as Chat GPT, obtaining visual materials no longer depends on their own talent and knowledge of software programs to create such materials. All they need is knowledge of the materials they want to be transferred into the visual medium. The Chat GPT free version ensures a fast and convenient variant of tool able to help anyone create visual materials for their courses. In addition, teachers can have a dialogue with Chat GPT and help improve these materials, which happens faster than in the case of a human being who could be a collaborator. Teachers may need much more time to create these visual materials than Chat GPT, even if they have enough digital skills, which gives AI an advantage. The visual materials are created almost on the spot, and they have a highly professional value.

3. Results

When we relate to another culture, we need to take into account their specific psychology, which can be understood based on notions of cultural awareness. We have seen certain features of the British, as well as their values, mentalities, common historical references, and communication style, which can help us build a psychological portrait. We can start relating to such a portrait based on considering how their stories have also been our own as we were growing up or even later in life, such as mysteries, adventure stories, detective and crime fiction, and, nowadays, thrillers. These stories allow us to consider both familiar and specific elements, since these stories do include typical British culture elements and references, and especially those related to a certain time period. As we become aware that we owe to British culture the way our society looks today, with its institutions and democratic possibilities, we realize that we may already be familiar with some aspects of this culture.

4. Discussion and Conclusions

By drawing British culture closer to students, and by making them aware of how they can be more familiar with it than it may be visible at first sight – including their close connections with everything related to the English language and with English-speaking cultures – we can help prevent for them the experience of culture shock. This method holds true not just for British culture and society, but also for any other culture and society. We can replicate the same steps: becoming aware of influences on our culture and on world culture, of how we may already be familiar with some aspects of the apparent foreign culture, of the image we have built of its members, and then by looking at historical and past references still of importance to today's life of its members. Afterwards, values, beliefs, principles, attitudes, practices, traditions, may also be considered. In addition, the visual identity of a place is also important and is, after all, the first one we notice as tourists or as temporary inhabitants of a foreign country.

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Arts in Education

Hands-On Learning through Pattern Design: A Stereotype Printing Workshop in Higher Design Education

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Abstract

This paper examines the pedagogical potential of a stereotype-printing workshop conducted in the Reprography course of the Design degree at the University of Aveiro. The study explores how hands-on, tactile engagement with manual printing techniques can support the learning of contemporary technical content in the field of graphic production and encourage the development of more meaningful visual solutions. The workshop challenged students to design modules featuring abstract motifs, subsequently produced in MDF, and to generate patterns by combining them. Students followed the entire production process, from graphic conception and preparation of final artwork to two-color printing. This approach recreated the fundamental principles of letterpress printing using limited workshop resources. The research methodology combined participant observation, visual documentation, and informal conversations with participants [1]. The results suggest that this type of workshop-based practice consolidates specific technical knowledge and fosters creative exploration that departs from common digital assumptions. The study concludes that integrating workshop practices and artisanal printing technologies into higher design education strengthens practical know-how, technological understanding, and a critical relationship between traditional means and contemporary practices, even in resource-constrained academic contexts. The relationship between manual know-how and sensory learning, as discussed in Hands-On Type [4] and The Touching Charm of Print [3], further supports the relevance of this pedagogical approach.

Keywords: *stereotype printing, patterns, workshop education, graphic production, graphic design, know-how*

1. Introduction

Since the 1970s, movable type printing has been progressively replaced by offset, which was in turn reinforced by desktop publishing in the late 1990s, a technology that, while democratizing graphic design and production, simultaneously contributed to the homogenization of visual solutions. The resulting loss of the tactile dimension and the unpredictable character typical of analog printing processes has gradually narrowed the creative and sensory repertoire of contemporary designers.

In contrast, recent years have seen renewed interest in reintegrating these obsolete printing technologies into higher design education.

This paper documents and analyzes a stereotype printing workshop developed within the Reprography course of the Design degree at the University of Aveiro during the 2021/2022 academic year. The workshop invited students to design modules featuring abstract motifs, produced in MDF through laser engraving, and to combine them into two-color printed compositions, following the procedural logic of movable type printing.

The study seeks to demonstrate how direct engagement with hands-on printing practices, even in academic contexts with limited material resources, contributes to developing the technical, creative, and reflective skills that an exclusively digital environment cannot provide.

2. Teaching Reprography at the University of Aveiro

Within the Design degree at the University of Aveiro, the Reprography course, taught in the first semester of this study cycle, aims to develop students' ability to recognize the limits of reprographic technology as factors for enhancing the expressive and creative potential of design work.

In this course, reprography is approached within the broader scope of graphic reproduction devices, processes, and equipment, along a dual chronological and technological axis. The syllabus is organized around three archetypal systems—mask, stamp, and transfer—to which other printing systems that do not fit the preceding categories are added. A further objective of the course is to familiarize students with the sequence of processes leading from graphic conception to finished product, namely final

artwork, prepress, printing, and finishing. This approach is conducted through theoretical and theoretical-practical classes.
The high number of enrolled students (between 40 and 55 per year) and the limited course load of two hours per week pose a considerable challenge for carrying out printing workshop activities, all the more so in a context where the available material resources are scarce, comprising only a single intaglio press. Finding creative pedagogical solutions that reconcile the syllabus requirements with these constraints, therefore, becomes essential.

3. Framework

3.1 The Technological Context and Know-How

The gradual shift away from so-called hot metal (lead type) toward cold type (phototypesetting), later driven by the expansion of desktop publishing software, led to the contemporary reality that Dias and Meira describe precisely: "(...) the consequence of this evolution is a saturated market where results are increasingly homogeneous (...)" [4]. Graphic solutions have become predominantly predictable, stripped of the tactile dimension and the unexpected character that distinguishes techniques such as letterpress or risography.
Against this backdrop, such technologies are increasingly recognized as holding significant potential for training new designers, both for the material experience they offer and for the conceptual possibilities they open up.
Several higher education institutions maintain or have come to incorporate workshops using this kind of technology, giving students access to a more tactile practice that broadens the way they think about design.
To quote Dias and Meira once again, "these workshops have proven to be a contribution to training on several fronts," fostering an understanding of the typographic profession and of how technological change has shaped the current state of reprographic printing, while at the same time deepening sensory knowledge through direct contact with physical matter—movable type, ink, substrate—as opposed to the digital medium, creating a space of inquiry capable of exploring all the dimensions referred to above [4].
But how might this kind of knowledge find concrete application in design practice?
One possibility is offered by the example of designer Dafi Kühne, who "(...) taking advantage of proof-press printing (...) extends his palette of materials for producing printing forms to a myriad of materials and technologies (...), which he explores avidly, without fear or conservatism" [4]. His approach is not that of a traditionalist seeking to recover a lost craft, but that of a contemporary designer for whom analogue and digital are not opposed terms: the workflow moves continuously between computer and press, and the choice of printing form is determined by the requirements of each project rather than by allegiance to a particular tradition [4]. These experiments are incorporated into work that responds to real-world briefs, yet whose final product carries the expressiveness and tactility that the digital medium cannot reproduce. The pedagogical relevance of the workshop discussed in this paper is direct; the use of laser-engraved MDF matrices follows the same logic, transposed to a resource-constrained academic setting.

3.2 Learning Through Practice — Know-How

The very etymology of *aprender* (the Portuguese verb "to learn"), from the Latin *apprehendere*—"to hold, to grasp"—situates the origin of knowing in the gesture of the hand, inscribing the body at the heart of the act of knowing [5]. It is this lineage that the tradition of learning by doing reactivates: the conviction that there is a kind of knowledge which is not transmitted through statements, but built in action, in contact with matter, and through attentive repetition.
This conviction resonates with Tim Ingold, for whom the only way to truly learn something—to know it from within—is to discover it for ourselves, by our own means [5]. Knowledge does not precede the practice that would apply it: it emerges from it. Know-how thus resides in the gesture and in the direct relationship with matter—a dimension of knowledge that is difficult to verbalize and can only be acquired by doing.
In education, this orientation has a long lineage, and it is in typography itself that it finds one of its most telling examples. Beginning in 1920, Célestin Freinet introduced a typography workshop into the classroom, in which pupils composed and printed a school newspaper—a method in which the act of typographic making was, simultaneously, a means of production and an instrument of learning [5]. For

Freinet, materially composing a word by handling the type was equivalent to knowing it "from every angle" and to fixing it in visual memory more intensely than handwriting would [5]. The same conviction runs through the devices of Fröbel and Montessori, for whom the hand is the instrument of intelligence, and, closer to our own time, through the laboratories of Bruno Munari, in which one learns by designing and manipulating [5]. Today, this tradition is being reactivated in typography and risography workshops, such as the Charles Nypels Lab or Knust, which restore a tactile and experimental dimension to higher education [6].

In the specific field of design, Nigel Cross argues that design constitutes an autonomous form of knowledge—designerly ways of knowing—distinct from the sciences and the humanities and grounded in making, in inventing, and in solving ill-defined problems [7]. This is a knowledge produced within the action itself: in stereotype printing, each decision—the amount of ink, the pressure, the alignment of the matrices—is made, assessed, and corrected in the moment. As Frascara et al. maintain, design methods are means through which a transformative praxis, productive of knowledge, is embodied [8]. It is this quality that Beckloff captures concerning typographic composition:

"Letterpress composition and printing reinforces the fundamentals of art and design and introduces designers to a new rhythm and mode of visual communication. Students must plan the layering depth of a piece from the outset through scale, color, and value. As they mix the ink color, they work with the inherent transparency of printing inks and learn to respond to the previous layer and to the printed color. Ultimately, there is no 'Undo' as in their digital comfort zones. There is an improvised quality implicit in the work, a need to adapt and move forward. (...)" [2]

4. Workshop

4.1 Context and Objectives

This workshop was developed within the Reprography curricular unit of the undergraduate Design program at the University of Aveiro, during the 2021/2022 academic year. The class, with 39 students, was organized into 8 groups in order to streamline both the creative work and the printing process. The exercise, part of a broader set of assignments developed throughout the semester, aimed to introduce students to a printing technique of industrial origin (movable type printing/stereotype printing), transposed into a non-industrial context while preserving the classic stages of the process and the logic of printing multiples.

In a curricular unit that is predominantly theoretical, it becomes necessary to find strategies that give students access to practical contexts so that this technical knowledge can be incorporated more naturally into their design practice. This is precisely what the workshop aims to provide: an understanding of the technique, recognition of its creative potential, and the possibilities for including it in future work.

Managing a class with such a large number of students was also a challenge, requiring organizational strategies that would ensure everyone could print within a very limited time frame. Hence, the decision was made to work in groups, while still preserving the possibility of individual authorship as a part of the process.

4.2 Methodology

This case study adopts a qualitative research approach, grounded in a pedagogical framework that conceives of learning as an active, dialogic, and experience-based process. Drawing on Freire's critique of the banking model of education, in which students are treated as passive recipients of knowledge rather than active participants in its construction, and on his conception of praxis as a continuous cycle of action and reflection [9], this workshop was designed to position know-how as a mode of thinking and knowing. In this approach, although students are provided with guiding directives, it is through hands-on workshop practice and through trial and error that embodied knowledge is achieved.

For Frascara et al. [8], design methods generate not only responses to situations but also new knowledge, a premise that frames the workshop as a setting where students learn by producing knowledge of their own, rather than receiving it.

To document this case study, the following data collection methods were used:

— Participant observation: the learning process, students' engagement, the technical challenges, and peer interaction (particularly the mutual support among students) were recorded through notes gathered over the course of the workshop sessions, capturing significant moments, conversations, and relevant observations.

— Visual documentation: photographic records of the process and of the results obtained.
— Informal interviews: casual conversations conducted with students before, during, and after the workshop, aimed at exploring their expectations, learning experiences, challenges, and discoveries, as well as their perception of the value of learning through practice.

4.3 Workshop Proposal, Structure, and Development

The initial brief asked each student to design (individually, yet already within a group setting) a 40 × 40 mm matrix featuring an original graphic motif, intended to coexist with the proposals of the other members of the same group and to be used in one or more final compositions. These matrices were to have the particular feature of being arranged in different configurations, giving rise to distinct and varied graphic patterns.
To deepen students' understanding of the logic of modular composition, a demonstrative example developed by the instructor was presented.

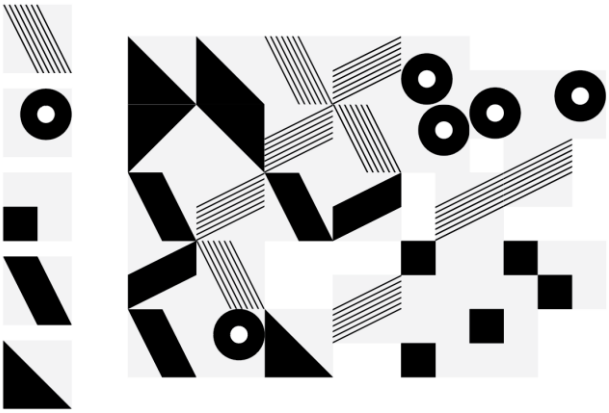


Fig. 1. A set of matrices (left) and one possible composition derived from them (right), developed by the instructor.

After each group had designed and selected its matrices, these were reproduced three-dimensionally, resulting in stereotype matrices, that is, matrices whose printing elements are in relief. Each group prepared a digital document with an engraving layout comprising a total of 35 matrices (5 originals × 7 repetitions), used for the laser engraving of the MDF. This process was carried out by the technician of the Department of Communication and Art workshop, with the students supervising.

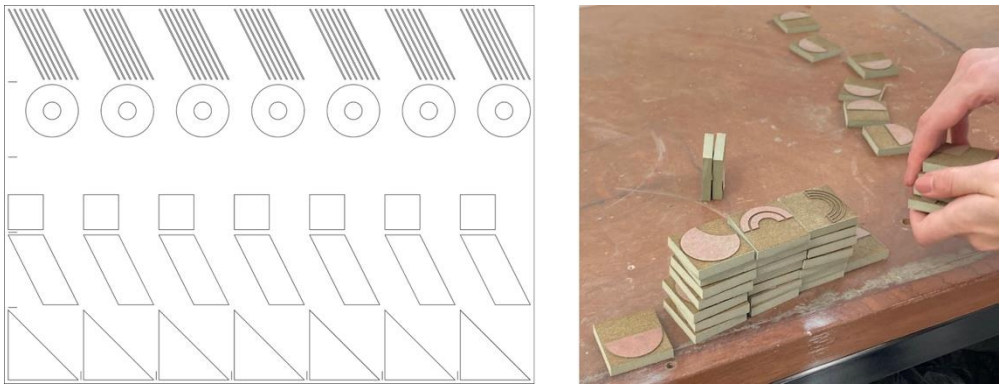


Fig. 2. Digital matrix layout and matrices produced in MDF.

Complementary material was developed to allow the printing layouts to be assembled. This material included a base (form) for fitting the matrices together and a set of blank, non-printing elements (of a lower height), whose function is to create the unprinted areas, keeping the composition contained within the selected format.



Fig. 3. Examples of the assembly of the matrices and the blank material on the base.

With the matrices available, each group designed a graphic composition to be printed in two colors in A3 format. This premise (printing in two direct colors) entailed assembling two distinct compositions that worked together, allowing the groups to take advantage of overlaps or (mis)alignments.

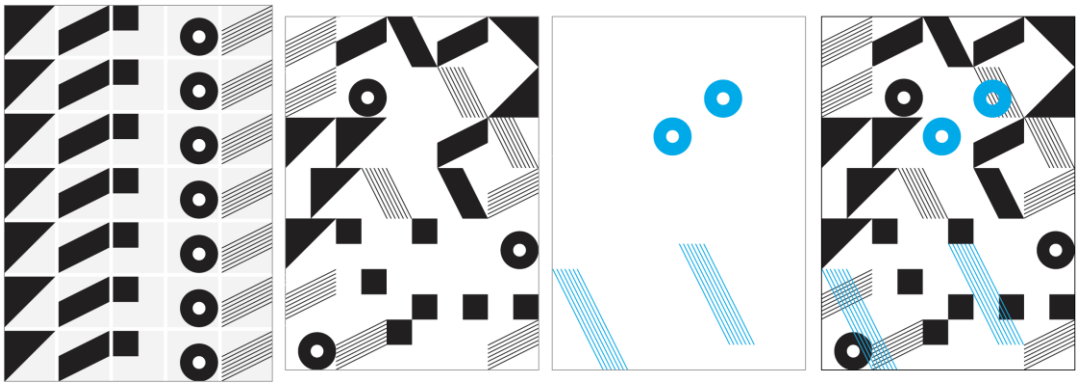


Fig. 4. Set of matrices, color separation (A and B), and a simulation of their overlay.

All of this work was considered preparatory to the printing session.
On the day of the workshop, each of the 8 groups had two hours to carry out initial experimentation and final printing, producing 10 copies in color A, 10 copies in color B, and 10 copies resulting from the combination of colors A and B. The choice of the paper type and weight to be used was the responsibility of each group. Some groups also experimented with printing on other substrates, such as papers of different weights and colors, cardboard and fabric, thereby creating complementary compositional solutions.



Fig. 5. Various moments of the printing process.



Fig. 6. Printed examples (1) of matrix, printed color separation and the result.



Fig. 7. Printed examples (2) of matrix, printed color separation and the result.

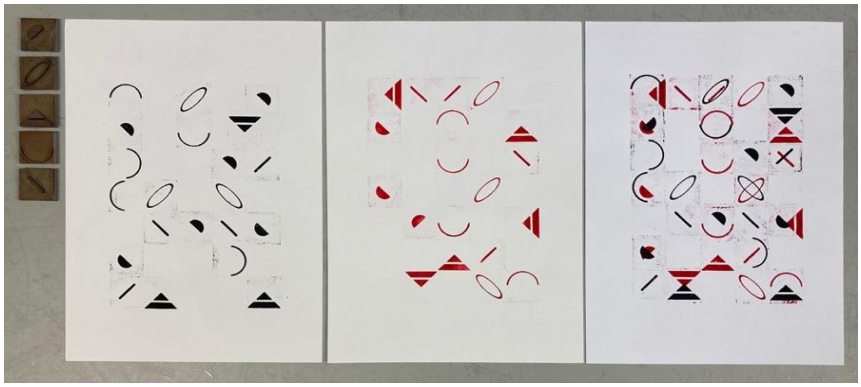


Fig. 8. Printed examples (3) of matrix, printed color separation and the result.



Fig. 9. Other printing substrates.

Groups were given the option of continuing to print outside the workshop setting, whether to pursue further experimentation or to refine the copies already produced.

The process concluded with an online presentation of the results obtained.

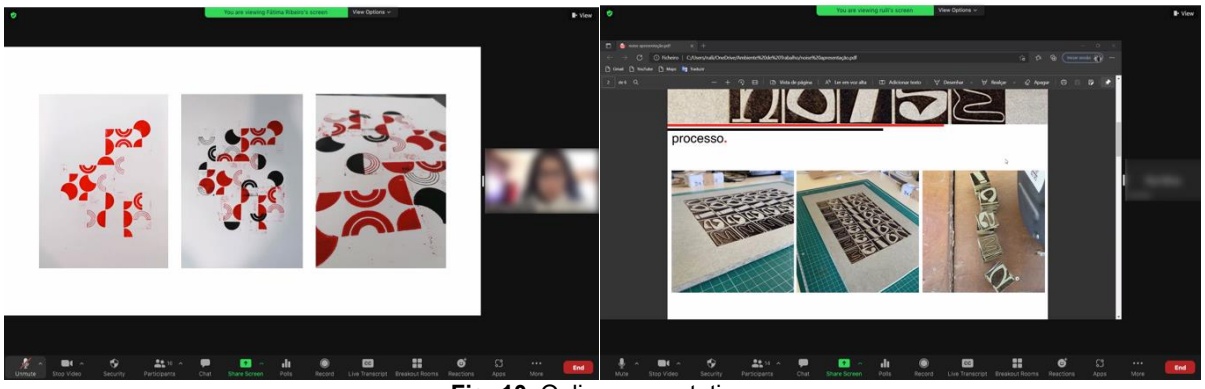


Fig. 10. Online presentations.

5. Discussion of Results

5.1 Technical Engagement with the Printing Process

The initial contact with the technology proved challenging for most students. The novelty of the process (assembling the matrices, preparing the base, managing the ink, and controlling the pressure on the printing press) gave rise to difficulties that were progressively overcome through repetition and growing familiarity with each stage. This learning curve, far from being an obstacle, was a meaningful pedagogical moment: the gradual overcoming of technical difficulties translated into a more conscious and informed command of the process.

The recurring cycles of inking, pressing, evaluating, and adjusting embodied what Freire describes as praxis: action and reflection oriented toward transformation [9]. Each misprint became an object of examination rather than a failure to be discarded, a variable to be identified (excess ink, insufficient pressure, a misaligned matrix) and corrected in the next attempt. In this regard, Beckloff's observation that "there is no 'Undo' as in their digital comfort zones" [2] acquires its full pedagogical weight: the impossibility of erasure compels students to think before and during the act of making, not only after it. The gap between digital simulation and printed result was thus not experienced as a deficiency but as the very ground of learning, consistent with the broadening of sensory knowledge that Dias and Meira identify in workshop practice [4].

5.2 Material Constraint and the Repositioning of the Digital

A particularly revealing dimension of the workshop was the way material constraints generated, rather than limited, creative possibilities. Several groups, having completed the initially planned compositions, extended the exercise on their own initiative, printing on cardboard, kraft paper, and fabric; deliberately misaligning the second color pass to produce unexpected chromatic interactions; combining matrices in configurations not foreseen at the design stage. These departures were not deviations from the brief but discoveries within it. Moments in which the fixed parameters of the medium (a 40 × 40 mm matrix, two ink colors, a single press) opened a creative space that the digital environment, with its infinite undo and its predictive simulation, tends to foreclose. This resonates with Cross's claim that designerly knowledge emerges from the situation itself, produced in the act of making [7].

The pedagogical intent of the workshop, it should be emphasized, was not to oppose the analogue to the digital, nor to propose a return to obsolete technologies. It was, more precisely, to displace the digital from its position as the unmarked default of design practice and to make it visible as one option among others. By encountering the assumptions that letterpress logic makes explicit (the fixed matrix, the sequential layer, the irreversibility of the printed mark), students gain a vantage point from which their common digital tools become legible as carrying assumptions of their own: about composition, about revision, about the relationship between intention and outcome. This estrangement is itself a pedagogical outcome, and one that aligns the workshop with the broader argument advanced throughout this paper.

6. Final Remarks

This study has shown that integrating hands-on printing practices into higher design education is not only feasible in resource-limited contexts but also pedagogically relevant and warranted. Direct engagement with analogue matrix-based printing technologies (in this case, stereotype printing) generates forms of knowledge that the digital environment cannot provide: embodied know-how, the management of unpredictability, an awareness of the sequential process, and an appreciation of the object produced. These results suggest that such experiences consolidate specific technical knowledge, stimulate creative exploration, and foster in students a more critical and informed relationship with the digital tools they use on a daily basis.

The apparent enthusiasm observed at the end of the workshop, expressed informally by students, suggests the pedagogical impact of an experience that demands presence, attention, and physical commitment to the process.

It is worth emphasizing that the model presented here is replicable in academic contexts that lack a printing press. The fundamental principle, adapting the logic of letterpress printing to matrices produced with accessible materials and technologies, can be transposed to different institutional realities, provided that the underlying pedagogical intent is maintained: to position making as a mode of thinking and knowing.

The main limitation of this study lies in the qualitative and informal nature of the data collection instruments used. The absence of more structured instruments, such as questionnaires or systematic assessment forms, limits the generalizability of the results. Future research could benefit from a more formal methodology, one that would allow results to be compared across different editions of the workshop or across different institutional contexts.

In a design education landscape increasingly dominated by the digital, the recovery of manual practices does not represent nostalgia, but a well-grounded response to the visual homogenization that characterizes the present. Integrating the analogue into the curriculum is, above all, a way of preparing designers who are more aware, more critical, and better able to inhabit the space between what technology allows and what creative intent demands.

Acknowledgements

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Reinterpreting Graphic Heritage through Design Practice: A Pedagogical Case Study

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Abstract

This article describes an academic design project developed in the undergraduate Graphic Design programme at the School of Design (ESD) of the Polytechnic University of Cávado and Ave (IPCA), in collaboration with the Municipality of Braga, as part of the Braga Capital of Culture (2025) programme and the centenary celebrations of Master José Veiga (1925 - 2002). A key figure in Braga's visual culture, Veiga produced an extensive body of work in drawing, graphic arts, and urban festive decoration, particularly for the Holy Week and St John's Day Festivities.
Two exhibitions were organised to reinterpret and disseminate Veiga's graphic heritage, combining reproductions of archival works – including posters, logos, lighting plans and urban decorative designs – with design projects developed by ESD/IPCA students. In the Graphic Design curriculum, students developed two exercises focused on visual identity and typography, aimed at creating contemporary visual sistems connected to Braga's cultural identity and festive traditions.
Combining theoretical research, semiotic analysis and practical experimentation, the project was structured in three phases: analytical research into Veiga's visual language; exploratory graphic experimentation; and the synthesis and formalisation of design proposals. The results, demonstrate the pedagogical and cultural potential of design practice as a process of critical reinterpretation of visual heritage, highlighting the relationship between historical graphic identity, contemporary visual language and cultural transmission.

Keywords: *Design Teaching; Visual Identity; Cultural Identity; Master José Veiga;*

1. Introduction

The project, developed as part of the Graphic Design degree programme at the School of Design of the Polytechnic University of Cávado and Ave (ESD/IPCA), in collaboration with the Municipality of Braga (Portuguese Capital of Culture 2025), is a notable example of how design education can serve as a tool for cultural mediation and the reinterpretation of visual heritage. As part of the centenary celebrations of *Mestre* (Master) *José Veiga* and the *Braga Capital of Culture 2025* programme, the project sought to establish a critical relationship between the city's visual heritage and contemporary design practices, whilst promoting pedagogical processes of research, experimentation and visual production.
Master José Veiga is a key figure in the 20th-century Braga's visual culture, noted for his work in drawing and the graphic arts and, above all, for the design of decorative elements associated with the *Semana Santa* (Holy Week) and *São João* (St. John's Day) festivities. The identity-forming dimension of his work highlights the capacity of graphic design and visual language to construct symbolic systems linked to the city's collective memory and cultural representation. As Fernando Pinheiro (2000) notes, José Veiga's work has established itself as a visual heritage deeply rooted in the urban life of the city of Braga, reflecting simultaneously tradition, religiosity and popular spectacle.
Building on this legacy, the students were challenged to develop contemporary graphic proposals capable of reinterpreting the formal, chromatic and symbolic elements present in the artist's work. Through this semiotic approach, students explored the processes of symbolic construction present in his visual language and developed experimental exercises in visual identity and typography, applying principles of form, colour, hierarchy, and composition. This project can be understood as both a pedagogical exercise in visual communication and a critical framework for reflecting on the relationship between design, cultural memory and graphic heritage. By reinterpreting the visual legacy of Master José Veiga, the project has created a dialogue between historical references and a contemporary visual language. This allows students to explore the role of design as a cultural and symbolic practice.

2. Theoretical Framework

The project's theoretical framework draws on contributions from visual communication theory, semiotics, visual syntax and identity systems, particularly the works of Joan Costa [1], Daniel Chandler [2], D. A. Dondis [3] and Fernando Pinheiro [4].
These authors provided the conceptual basis for understanding visual heritage as an active system of visual signs capable of generating new meanings within contemporary design practice, rather than simply as a historical archive.
Fernando Pinheiro's work on Master Veiga is a key historical and cultural reference for the project. In *Mestre José Veiga: O Artista Tranquilo – Vida e Obra de um Artista Consagrado Pela Cidade de Braga* (2000), Pinheiro documents the artist's contribution to Braga's visual culture, emphasising the relationship between his artistic production and the city's symbolic identity.
This understanding of visual production as a cultural system is closely linked to Daniel Chandler's thoughts on semiotics. In *Semiotics: The Basics* (2005), he argues that images operate as systems of signs whose meanings are culturally constructed and socially interpreted. From this perspective, the visual elements present in Master Veiga's work, such as ornamental structures, religious iconography, typographic forms and chromatic compositions, cannot be interpreted as mere aesthetic objects. Instead, they serve as carriers of collective meanings associated with local traditions, spirituality, celebration and urban identity.
The semiotic dimension of the project was further reinforced through the exploration of visual language and compositional principles set out by D. A. Dondis in *La Sintaxis de la Imagen* (2008). Dondis proposes that visual communication operates through a 'visual syntax', composed of formal relationships such as balance, contrast, rhythm, proportion, hierarchy and scale. These principles enable visual messages to achieve coherence, expressiveness and clarity of communication.
Dondis also emphasises that visual literacy encompasses more than just technical skill; it involves the capacity to critically interpret and construct visual meaning. This perspective was particularly important in the educational context of the project, in which students were encouraged to move beyond stylistic imitation and engage in critical design thinking.
The relationship between visual identity and symbolic construction was further developed through the theoretical contributions of Joan Costa. In *Design para os Olhos – Marca, Cor, Identidade, Sinalética* (2011), he examines how visual identity systems function as strategic instruments of communication and recognition. For Costa, identity is not restricted to logos or formal aesthetics; rather, it emerges through coherent visual systems that can express cultural values, institutional narratives and collective belonging. This perspective was particularly relevant to the students' proposals, which aimed to create contemporary visual symbols connected to Braga's festive traditions and graphic memory.
Integrating these theoretical perspectives shows how design education can be an interdisciplinary space for producing knowledge, combining historical research, cultural analysis, visual experimentation and critical interpretation. Rather than treating heritage as a static object of preservation, the project approached graphic memory as an evolving and dynamic field of visual culture. By reinterpreting Master Veiga's archive, students explored processes of cultural transmission, where contemporary design practice acts as a mediator between the past and the present.
The resulting exhibitions reinforced this dialogical relationship by placing historical works and contemporary student proposals side by side. This curatorial strategy revealed how graphic heritage can generate new visual narratives while preserving its symbolic and cultural significance. The coexistence of archival material and experimental design outcomes showed that heritage's value lies not only in conservation, but also in its ability to inspire reinterpretation, critical reflection and renewed cultural relevance.
Ultimately, the project highlights the importance of connecting design education with local cultural contexts and historical archives for pedagogical purposes. By engaging directly with Braga's visual heritage, students developed technical and conceptual design skills, as well as a deeper awareness of the social and cultural responsibilities of graphic design.

3. Methodology

The project's theoretical framework draws on contributions from visual communication theory, semiotics, visual syntax, typography and identity systems. This establishes a methodological structure that guides the analytical and practical dimensions of the design process. As the project focused on reinterpreting Master Veiga's graphic work, it adopted a methodology combining historical investigation, semiotic analysis, visual experimentation, and conceptual synthesis.

The first methodological stage focused on research and analytical observation. Students began by examining archive materials related to Master Veiga's work, including posters, typographic compositions, decorative studies, lighting plans and urban festive designs. This involved identifying recurring visual structures, symbolic motifs, compositional systems and chromatic strategies in the artist's work. Through close visual analysis, students were encouraged to understand the formal qualities of the works and their cultural and communicative functions within Braga's visual identity.
This analytical phase was strongly influenced by semiotic theory, particularly the concept that visual artefacts function as systems of signs within social and cultural contexts. Semiotic analysis enabled the students to decode these symbolic dimensions and transform them into conceptual references for contemporary design proposals.
A second methodological component involved studying visual syntax and compositional organisation. This stage was particularly important for understanding how Master Veiga structured large-scale festive compositions and graphic systems intended for public spaces. By analysing the relationship between form, colour, typography and ornamentation, the students developed an awareness of how visual language can guide perception and produce an emotional and symbolic impact.
The project methodology incorporated exploratory and experimental design practices. Students explored how colour, typography, symbols and compositional structures could function together as elements of identity associated with Braga's festive culture. The methodology therefore extended beyond isolated graphic objects, encouraging the development of integrated visual systems that were both consistent and culturally relevant.
Another important methodological aspect of the project was the relationship between theory and practice. The design process was conceived as a reflective activity in which research, analysis, experimentation and production continuously informed one another. Students were encouraged to justify formal decisions conceptually, relating visual outcomes to the theoretical frameworks and cultural references. This pedagogical approach reinforced the idea that graphic design is a form of critical and cultural inquiry as well as a technical discipline.
The final methodological phase involved synthesis and formalisation. At this stage, students refined their proposals to create coherent visual outcomes inspired by Braga's cultural heritage.
These proposals were then presented in exhibitions alongside original works by Master José Veiga, establishing a dialogue between the historical archive and contemporary interpretation. This curatorial dimension became an extension of the methodology itself, reinforcing the continuity between research, design experimentation and public cultural dissemination.
Overall, the adopted methodology demonstrates how graphic design education can integrate historical research, theoretical reflection and creative practice into a unified pedagogical framework. By combining semiotic analysis, visual syntax, identity systems and experimental design processes, the project enabled students to critically engage with historical graphic artefacts, developing contemporary visual responses that are firmly grounded in cultural memory and local identity.

4. Practical Design Exercises – Case Study

As part of the Braga Capital of Culture 2025 programme and the centenary commemorations of Master José Veiga (1925–2002), two exhibitions were organised to disseminate and reinterpret Veiga's graphic legacy. The exhibitions brought together reproductions of original works, including posters, logos, lighting plans and urban decorative compositions, sourced from personal and municipal archives. They were displayed alongside projects and experimental exercises developed by students from the School of Design (ESD/IPCA).
This case study examines two design exercises developed in the undergraduate Graphic Design curriculum. Focusing on visual identity and typography, the projects aimed to explore the creation of visual systems that could express regional identity and critically engage with Braga's key festive traditions.

4.1 The Aim: Master Veiga's Legacy

José Veiga (1925-2002), also known as Master Veiga, occupies a significant position in the visual and cultural history of Braga. He is particularly renowned for his contributions to drawing, graphic arts, urban ornamentation and festive visual culture. Recognised locally as an artist deeply connected to the city's identity and traditions, Veiga produced an extensive body of work combining artistic sensitivity with a profound understanding of Braga's symbolic and cultural landscape. His work reflects technical skill, aesthetic refinement, and a strong capacity to translate collective memory and regional identity into

visual form. Born in Braga in 1925, Veiga developed his artistic practice within a context strongly influenced by religious traditions, popular festivities and urban ceremonial culture. Throughout his career, he became particularly associated with the visual representation of Braga's most emblematic celebrations, namely the Holy Week processions and the St. John's festivities. These events, deeply rooted in the city's collective experience, provided a context in which graphic design, scenography, ornamentation and public visual communication intersected.

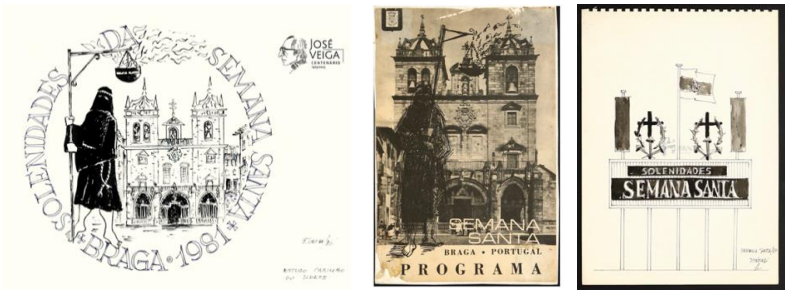


Fig. 1. Master Veiga's sketches and drawings for posters and decorations of the festivities (1980 – 1982). (© José Veiga Fund – Braga Municipal Archive)

According to Fernando Pinheiro (2000), Veiga was widely recognised for the coherence and originality of his artistic language, characterised by precision in drawing, ornamental richness, and a strong sense of compositional balance. He demonstrated an ability to merge traditional decorative motifs with modern graphic sensibilities, producing visual systems that were simultaneously popular, symbolic and formally sophisticated. This capacity enabled his work to become deeply integrated into Braga's urban identity, transforming temporary festive decorations into lasting visual references in the city's collective memory.
One of the most distinctive features of Master Veiga's work was his involvement in designing illuminated structures and decorative installations for public festivities. These large-scale urban compositions incorporated graphic rhythm, symmetry, repetition and chromatic contrast, revealing a sophisticated understanding of visual perception in architectural and public spaces. The ornamental structures created for Holy Week and St. John's celebrations often combined religious symbolism with festive exuberance, creating environments that served as both artistic compositions and shared cultural experiences.
Veiga's graphic work also included posters, logos, lettering, illustrations, and visual identity elements for institutional and cultural events. His graphic language was characterised by his careful attention to typography, ornamental detail, and symbolic communication. Many of his posters and visual compositions strike a balance between figurative representation and geometric organisation, demonstrating a visual logic that anticipated contemporary concerns within graphic design and visual identity systems. Colour played a central role in his artistic practice. His colour choices often emphasised contrast and luminosity, particularly in projects intended for public celebrations and nocturnal urban settings. Light itself became an expressive medium in many of his festive installations, transforming streets and public squares into immersive visual landscapes. Through these interventions, Veiga contributed to the creation of a unique visual atmosphere that has come to symbolise Braga's cultural identity.
Another important aspect of his work was the relationship between craftsmanship and graphic composition. Although much of his work emerged in the context of festivities and was therefore ephemeral, his projects reveal rigorous planning and compositional discipline. His drawings and preparatory studies demonstrate an attention to proportion, rhythm and structural organisation, aligning his work with principles commonly associated with graphic design and visual communication. This combination of artisanal sensitivity and graphic rationality is what makes his visual language unique.
His work is a prime example of how graphic and decorative arts can contribute to the development of urban identity and collective memory. By integrating artistic practice with public celebration and cultural representation, Master Veiga created a visual language that connected community, ritual and space. His archive, comprising drawings, plans, posters, decorative studies and graphic compositions, represents an invaluable artistic collection and an important document of Braga's visual culture throughout the twentieth century.

4.2 Exercise 1: Identity Signs in the Graphic Work of Master Veiga – Holy Week Posters

This exercise was developed by approximately 40 second-year students of the bachelor's degree in graphic design, in the scope of the Graphic Design Project II course, and took place over four sessions of three hours each. The students were organized into groups of two to three members.
The exercise was based on an analysis of Holy Week posters designed by Master Veiga for the city of Braga. It aims to identify the visual and identity-related elements that characterise the author's graphic language and visual aesthetics. By examining these works, students could understand how formal composition, symbolism, typography, colour and graphic synthesis contribute to creating a coherent and recognisable visual identity. Supported by a theoretical contextualisation of the formal and conceptual principles of identity design and an understanding of the theoretical and practical requirements of basic identification signs, students explored graphic solutions for different logo and brand typologies, including typography, form, and colour to develop visual systems capable of communicating Braga's cultural identity and the symbolic universe associated with its festive traditions.



Fig. 2. Master Veiga's posters for the Holy Week festivities (1957 – 2002).
(© José Veiga Fund – Braga Municipal Archive)

This visual analysis reveals a graphic language that is strongly defined by formal synthesis, symbolic expressiveness and chromatic restraint. The compositions are characterised by simplified forms, strong contrasts, balanced relationships between figure and background, and a clear visual hierarchy.
Religious and cultural symbolism also plays a central role in Master Veiga's visual language. Recurring motifs, such as crosses, processional figures, candles, crowns of thorns and references to Braga's religious architecture, are stylised and integrated into highly synthesised compositions with symbolic and identitarian dimensions.
Colour is another fundamental component of the poster's visual impact. Composed predominantly of black, purple, red, white and gold tones, the chromatic palette conveys values associated with solemnity, spirituality, sacrifice, purity and tradition. The restrained use of colour and the emphasis on contrast contribute to the emotional and symbolic intensity of the graphic compositions, Meanwhile, typography assumes both informational and visual functions. The use of serif typefaces, balanced compositions and clearly structured hierarchies reinforces the posters' ceremonial and institutional character while contributing to their visual coherence.



Fig. 3. Students' proposals: colour palette; typography; abstract, figurative and typographic symbols (©IPCA).

Within this framework, students developed proposals exploring various approaches to visual identity. Typographic solutions focused on the expressive and structural potential of letterforms, while abstract proposals explored geometric and symbolic synthesis. On the other hand, figurative approaches incorporated stylised representations directly associated with the iconography of Holy Week. These exercises enabled students to investigate how visual identity design can communicate cultural, historical and emotional values through coherent and memorable graphic systems.

4.3 Exercise 2: 'Quadrícula' (Grid) Workshop

The '*Quadrícula'* workshop took place in a classroom setting with 40 first-year bachelor's degree in graphic design (ESD/IPCA). The workshop began with a detailed observation and critical analysis of posters and lighting design sketches created by Master Veiga for the St. Jonh's Festivities in Braga. During this initial phase, the students were encouraged to identify and analyse the key graphic and symbolic elements that define those festivities visual language. These elements included compositional structures, iconographic motifs and stylistic characteristics.



Fig. 4. Veiga's posters for St. John's festivities (1955 – 2002). (© José Veiga Fund – Braga Municipal Archive)



Fig. 5. Veiga's original drawings for the lightening and decorations of St. John's festivities (n.d.). (© José Veiga Fund – Braga Municipal Archive)

Building on this analytical foundation and drawing inspiration from Master Veiga's approach to constructing visual compositions, the students developed a modular grid system ('quadrícula'). This grid system served as a structural framework for organising visual elements, providing the basis for the creation of original icons and symbolic interpretations.



Fig. 6. (left) Master Veiga's graph paper drawings for planning colour lamps used in festive decorations (n.d.). (© José Veiga Fund – Braga Municipal Archive) **Fig. 7.** (right) Students' graph paper drawings (© IPCA).

Within this system, each student translated their graphic explorations into modular units, exploring rhythm, repetition and structure as compositional principles. The grid ensured visual coherence and encouraged a systematic and controlled approach to image construction, reflecting processes commonly used in typographic and identity design.

Using *FontStruct*® software [6] (for modular typeface design), students digitally constructed their proposals, resulting in the creation of a set of symbolic typefaces designed for download and practical

application. This digital translation of analogue exploration enabled students to grasp the relationship between structure and flexibility in type design, as well as the constraints and potential of modular systems.



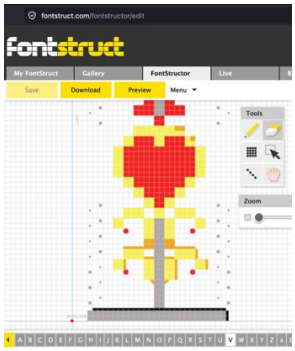


Fig. 8. (left) Process (© Cristiana Serejo). **Fig. 9.** (right) Digital drawings for VEIGA symbolic typeface.

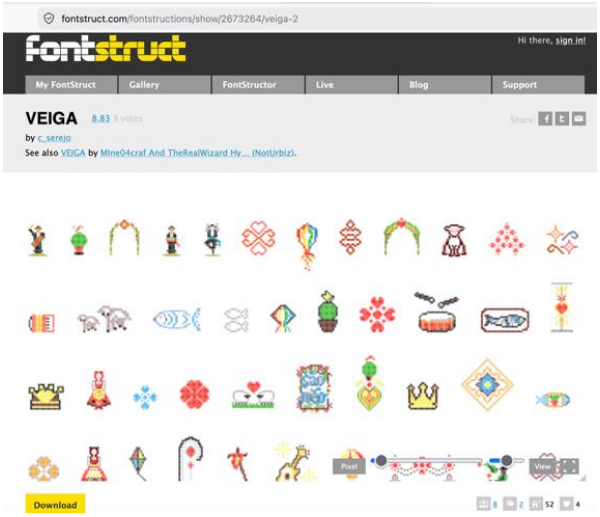




Fig. 10. (left) Final digital drawings of VEIGA symbols typeface [6], ready to download. **Fig. 11.** (right) Page with VEIGA symbols already in use.

The exercise aimed to stimulate systematic thinking and foster the creative appropriation of traditional elements, encouraging a contemporary reinterpretation of the Braga St. Jonh's Festivities visual heritage.

5. Final Considerations

This project demonstrated how graphic design education can function as a pedagogical, cultural and critical practice simultaneously. By analysing and reinterpreting the graphic legacy of Master José Veiga, students explored the relationship between graphic heritage, cultural memory and contemporary visual communication through processes of visual research, semiotic interpretation and experimental design.
Integrating theoretical frameworks related to semiotics, visual syntax and identity systems enabled students to understand visual culture as an active field of symbolic production, capable of generating new meaning through contemporary design practice, rather than simply as a historical archive. By analysing Master Veiga's work, the students developed an awareness of how visual forms, colour, typography and composition contribute to the construction of collective identity and urban cultural representation.
Practical exercises reinforced the value of connecting historical research with experimental methodologies. Through processes of observation, abstraction, synthesis and format experimentation, students produced contemporary graphic proposals based on Braga's festive traditions and visual culture. Rather than simply reproducing historical forms, the exercises encouraged critical analysis and

reinterpretation, enabling students to transform historical materiality into new visual graphics adapted to current contexts of communication and design practice.
The exhibitions played a key role in establishing a dialogue between the past and the present. By presenting student projects alongside original works from Master Veiga's archive, they revealed how graphic heritage can remain culturally relevant through reinterpretation and educational engagement. This curatorial approach emphasised design's ability to bridge memory, identity, and contemporary visual language, underscoring the vital role of archives as dynamic educational and cultural resources.
This case study also demonstrated the importance of collaborative work between higher education institutions and cultural organisations in promoting local heritage and public cultural participation. The collaboration between ESD/IPCA and the Municipality of Braga provided students with the opportunity to engage directly with the city's visual heritage, contributing to the dissemination and contemporary reinterpretation of a significant cultural legacy within the framework of Braga's 2025 European Capital of Culture programme.
Ultimately, this case study confirms the potential of design education to contribute to processes of cultural transmission, critical reflection, and visual innovation. By connecting design pedagogy with local heritage and collective memory, the project established a framework in which contemporary graphic practice becomes a form of cultural enquiry and a means of renewing the symbolic significance of historical visual identities in contemporary society.

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Diagnosing AI Adoption among Arts and Multimedia Students: Insights from Viseu School of Education, Portugal

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Abstract

The rapid integration of generative artificial intelligence (AI), particularly within artistic practices, challenges established pedagogical paradigms [1] and reinforces transformations associated with the post-digital condition [2]. Ethical concerns persist regarding originality, authorship, and the reconfiguration of creative labour [3]. At the level of international policy, both the EU AI Act [4] and the OECD Digital Education Outlook [5] emphasise responsible AI integration in education, highlighting transparency, risk management, and the development of AI literacy as strategic priorities for higher education institutions.
This paper presents an exploratory diagnosis of AI adoption among students enrolled in the Arts and Multimedia degree at the Viseu School of Education, Portugal. Drawing on survey data collected in October 2025 (n=90), the study analyses usage patterns, domains of application, levels of confidence, and student perceptions regarding AI tools. Results indicate that the majority of students (57,8%) who use AI (n=53) integrate it primarily through self-directed initiative, with pronounced use in image generating or editing, programming support and colour palette definition. Participants report moderate confidence in selecting appropriate platforms and acknowledge a strong perceived need for external guidance. Perceptions are markedly sceptical regarding AI reliability for decision-making and data privacy, while students strongly agree that AI tends to produce stereotyped images.
In the context of research on AI in higher education [6] and current international regulatory frameworks, this study argues that the integration of AI in arts education cannot be guided solely by technological trends. The definition of effective pedagogical strategies must be grounded in a situated understanding of student practices and perceptions and crucially, in the recognition that ease of use does not imply critical engagement. Diagnosing student perceptions thus emerges as a necessary first step toward aligning technological innovation, ethical responsibility, and AI literacy within contemporary arts education.

Keywords: *Artificial Intelligence; Creativity; Fine Artes; Multimedia; Higher Education, AI Literacy*

1. Introduction

What schools should teach today is a question that remains ever-relevant and of vital importance. The challenges posed by the widespread use of generative artificial intelligence in everyday life and in the learning practices of higher education students raise urgent questions across all disciplines. We are interested in the specific case of education in Arts and Multimedia, where issues such as authorship, originality, creativity and graphic identity are not resolved through efficiency or process optimisation, but involve core disciplinary values such as the meaning of learning trough making, the relationship between intention and artefact, and the cultivation of aesthetic judgement [1]. As Siagian et al. [3] emphasise, generative AI raises critical questions regarding the attribution of creative work and the dilution of individual artistic contribution; these tensions become even more complex when considered in light of the ambivalent attitudes that the students themselves, artists in training, express towards AI as a creative agent [7].
International regulatory frameworks such as the EU AI Act [4], the OECD Digital Education Outlook [5] or the European Commission's Ethical Guidelines on the Use of Artificial Intelligence (AI) and Data in Teaching and Learning for Educators [8], identify AI literacy as a strategic priority for higher education, emphasising the need for responsible adoption that encompasses critical awareness, ethical reasoning and practical competence. However, these frameworks are necessarily generic, and their translation into situated pedagogical practice requires empirical grounding to understand who uses AI, how, and

with what perceptions and expectations. It is precisely in this gap that we find the relevance of this contribution.
This article presents an exploratory assessment of AI adoption among students on the Bachelor's degree in Art and Multimedia at the Polytechnic Institute of Viseu, School of Education, in Portugal. Data were collected via a survey in October 2025 (n=90), covering the three academic years of the degree programme. The aim is not to evaluate the tools themselves, but to understand the current landscape of students' practice as a basis for informed and responsible pedagogical interventions, in line with the call by Zawacki-Richter et al. [6] for evidence grounded in situated practices.
The article is organised as follows: Section 2 situates the study within the theoretical and political debates on AI in arts education; Section 3 describes the methodology; Section 4 presents the results; Section 5 discusses the results in dialogue with the literature; Section 6 concludes with implications for pedagogical practice and directions for future research. In a study that draws on an examination of students' practices and perceptions, it seemed appropriate to us that their voice should also be present in the structure of the text. It is from this voice that the central argument emerges: students describe AI as simultaneously 'convenient' and 'potentially disempowering', a tool which, whilst facilitating processes, can weaken critical thinking.

2. Theoretical Background

2.1 AI and Arts Education: Between Tool and Co-Creator

The post-digital condition, as theorised by Conrad, Leijsen and Héritier [2], describes a cultural state in which digital technologies are no longer perceived as a novelty but have become part of everyday creative practices. The emergence of generative AI represents a profound shift in how artists and students collaborate with technology, one that they are called upon to reflect upon. By producing probabilistic results derived from vast training datasets, AI tools position themselves not as neutral instruments, but as co-creative agents with their own aesthetic tendencies and cultural biases, a dimension which, as we shall see, the students themselves identify and problematise.
Fleischmann [1] documented these tensions within the context of graphic design education, showing how generative AI introduces significant conflicts between technological availability and disciplinary identity. For art students, the issue is not merely learning to use a new tool, but negotiating what it means to be an author, what distinguishes an aesthetic decision from an algorithmic suggestion, and to what extent the creative process can be delegated without losing meaning.

2.2 To Make or to Generate? Tensions in Visual Arts

Questions regarding authorship, what makes a work original, or what distinguishes creation from reproduction, have long been central debates in the visual arts, and the integration of generative AI has reignited them. As Siagian et al. [3] point out, generative AI raises critical questions about the attribution of creative work and the dilution of individual artistic contribution. When a student uses a generative system to obtain an image, define a colour palette or generate code, the *locus* of creativity becomes ambiguous, with direct implications for the formation of their expressive artistic identity and, considering the educational context, for the assessment criteria that should be prioritised to ensure academic integrity.
This ambiguity often manifests in technical domains before becoming apparent in aesthetic ones, but tends to spread throughout the entire project. When students turn to AI to solve programming problems, as the data from this survey document shows, they often do so without questioning the extent to which this technical delegation influences subsequent creative decisions. Latikka et al. [7] demonstrated widespread acceptance of the use of AI for technical optimisation across various fields of knowledge and activity, but the closer the use of AI comes to the core of creative practice in the arts, the less positive its acceptance becomes, with greater value placed on human creative intelligence and artistic expressiveness.
Making implies intentionality, embodiment, iteration, the resistance of the material, learning from error, the integration of error, and discovery during the creative design process. Generating implies prompting, selection and curation, which are real skills, but of a distinct nature. Generative systems also tend to reproduce the dominant patterns of their training data, producing results that mirror established aesthetic conventions, a tendency towards visual stereotyping that the data from this study confirm and which diminishes the possibility of a plural visual culture. The pedagogical question is not which of the two practices is superior, but whether students develop an awareness of the difference and the ability to

move between them with critical discernment, which leads us to the need to develop, with the students, the ability to identify, understand, interpret, create and communicate.

2.3 AI Literacy and Regulatory Frameworks

The concept of AI literacy refers to the set of skills that enable people to critically understand AI technologies and use them in an informed manner in different contexts of life and work [9]. This is a concept that goes beyond technical competence: it involves critical, ethical, and reflective dimensions that are particularly relevant in arts education, where easy access to tools does not guarantee a critically situated use.

In the European context, the European Commission's Ethical Guidelines [8] serve as a reference framework for the responsible use of AI in education. The document identifies four fundamental ethical considerations—human agency, equity, humanity and justified choice—and proposes a set of emerging competences for educators, organised into six domains, ranging from professional engagement to facilitating students' digital competence. It is important to highlight from this guidance document that the most advanced AI systems do not assess collaboration, social skills, or creativity, a gap of relevance to arts education. The EU AI Act [4] reinforces this framework through risk-based governance, explicitly requiring users of AI systems to ensure adequate levels of literacy. The OECD Digital Education Outlook [5] expands on this agenda at a systemic level, calling for pedagogical approaches that are not only technical but also ethical and critical, and recognising that the widespread adoption of generative AI poses specific challenges to which higher education institutions have not yet responded adequately.

A common denominator to these three frameworks, however, is their necessarily generic nature. The systematic review by Zawacki-Richter et al. [6] demonstrated that existing research on AI in higher education is dominated by perspectives from computer science and STEM fields, with a very limited presence of authors from education departments. The authors conclude that there is a critical lack of pedagogical and ethical reflection on the implementation of AI and call for research centred on the situated practices of students and educators. It is precisely this gap that the present study addresses: the need to understand students' uses of AI, what they perceive, and where they feel they need guidance. The empirical analysis that follows is based on this premise.

3. Methodology

This study adopts an exploratory and descriptive research design, combining quantitative data with open-ended responses of a qualitative nature. The exploratory approach reflects the diagnostic purpose of the study, which is to generate a situated understanding (at the Polytechnic Institute of Viseu, School of Education) of the adoption of AI among a specific student population (students in the third year of the bachelor's degree in art and Multimedia), without seeking to test pre-established hypotheses.

The data collection instrument was a structured questionnaire, developed specifically for this study and made available online in Portuguese via the Google Forms platform in October 2025. The questionnaire was preceded by an informed consent form, with participation being voluntary and anonymous. It was organised around six dimensions: 1) identification of academic year and prior experience with AI in the visual arts; 2) contexts, types of use, platform preferences and modes of access; 3) perceptions of AI within the visual arts; 4) frequency of use for personal and academic projects; 5) self-perceived autonomy in the use of AI; 6) overall opinion on the use of AI in three words. Responses were of the open-ended, closed-ended, and five-point Likert scale types.

The questionnaire was administered in a classroom setting to all students present at the respective sessions, one per academic year, with one of the co-authors always present. The total number of respondents (n=90) is distributed across the three academic years of the study programme.

The analysis of quantitative data was based on descriptive statistics, including frequencies, percentages, and measures of central tendency for the Likert scale items. The open-ended responses were subjected to content analysis with inductive thematic categorisation. Given the exploratory and diagnostic nature of the study, no inferential tests were applied.

4. Findings

4.1 Adoption Profile: Prevalence, Platforms and Contexts

The 90 students surveyed are distributed across the three academic years of the programme as follows: 40.0% are in the first year (n=36), 38.9% in the second year (n=35), and 21.1% in the third year (n=19).

Of the 90 participants, 58.9% (n=53) stated that they use or have used AI in the context of the visual arts, constituting the *corpus* for the analysis. Analysing the figures by academic year, the majority of occasional users coexist, however, with a minority of occasional users who have no experience of using these tools, suggesting that adoption, although widespread, is neither universal nor uniform.

Table 1. Students use of AI in Visual Arts.

Academic Year	Number of Responses		Students use of AI in Visual Arts			
	(n=)	(%)	Yes (n=)	Yes (%)	No (n=)	No (%)
Year 1	36	40,0%	15	41,7%	21	58,3%
Year 2	35	38,9%	22	62,9%	13	37,1%
Year 3	19	21,1%	16	84,2%	3	15,8%
Total	**90**	**100%**	**53**	**58,9%**	**37**	**41,1%**

Regarding the contexts in which AI is used in the visual arts, the questionnaire identified formal contexts in pre-university and university education, whether at the teacher's suggestion or on the students' own initiative, as well as its use for personal artistic projects. The responses point to a predominance of self-directed use by students. It is considered significant that first-year students who report using AI demonstrate a practice that was established during their high school education. As the survey was conducted at the start of the academic year, the use of AI by these first-year students is not guided by relevant higher education lecturers; however, second- and third-year students provide good indicators of the integration of AI into the teaching practice of lecturers in the Art and Multimedia degree programme. In the context of independent use of AI within the degree programme, students demonstrate increasing confidence over the course of the three-year programme, a confidence that can also be interpreted as dependence.

Table 2. Contexts in which students use AI in the Visual Arts.

Academic Year	Contexts in which students use AI in the Visual Arts									
	In secondary education, recommended by a teacher		In secondary education, on my own initiative		In current degree programme, recommended by a teacher		In current degree programme, on my own initiative		For personal art projects	
	n=	%	n=	%	n=	%	n=	%	n=	%
Year 1 (n=15)	9	60,0%	10	66,7%	2	13,3%	7	46,7%	8	53,4%
Year 2 (n=22)	2	9,1%	6	27,3%	10	45,5%	14	63,6%	10	45,5%
Year 3 (n=16)	2	12,5%	1	6,3%	7	43,8%	12	75,0%	8	50,0%
Total (n=53)	**13**	**24,5%**	**17**	**32,1%**	**19**	**35,9%**	**33**	**62,3%**	**26**	**49,1%**

Among student users, access is almost exclusively via free versions of generative AI platforms (94.3%), with ChatGPT clearly dominating the open-ended responses (notably for programming purposes, as we shall see in 4.2). Of the 46 validated responses, 44 mention the use of ChatGPT (95.7%), 27 of which exclusively (61.4%). These are followed by the platforms Gemini (18.2%), DeepSeek (6.8%), Adobe Firefly / Adobe AI (6.8%) and, to a lesser extent, BLACKBOX AI, Leonardo AI, Luma AI, ElevenLabs, Suno, Hyper3D and, for learning support or the distribution of AI resources, KnowUnity and CivitAI. Although several generative AI platforms were identified, the concentration on a general-purpose platform (ChatGPT), accessed in its most limited version, indicates that the diversity of creative AI tools available remains largely unexplored by students.

4.2 Domains of Practice: What Students Actually Do

To analyse the types of tasks for which students identified the use of AI within the field of Visual Arts (n=53), the data was collated from multiple-choice and open-ended responses, resulting in eight tasks: Programming; Generating or Editing Images; Defining Colour Palettes; Generating or Editing Audio; Generating or Editing Video; Generating 3D Models; Researching a Topic; Summarising / Improving Text. Each task is examined in terms of the total number of references made by students and then

organised by academic year. The analysis shows that Generating or Editing Images is the most frequently cited application area, having been mentioned by 26 students (49.1%). This is followed by the task of Programming with 24 references (45.3%) and Defining Colour Palettes with 16 entries (30.2%). Researching a Topic was mentioned 12 times (22.6%) and Summarising / Improving Text received 8 responses (15.1%). The domains Generating or Editing Audio, Generating or Editing Video and Generating 3D Models recorded considerably lower figures, ranging from 9.4% to 5.7%.
Analysis by academic year shows that students increase their use of AI throughout their studies, accounting for 27.3% in the first year, 33.3% in the second year and 39.4% in the third year. This progression is consistent with the evolution of the Art and Multimedia curriculum, given that the modules gradually introduce new or more complex skills and areas of application, creating a need to explore different domains of AI use.
The greatest percentage increase in usage across the three academic years is seen in Programming (+464%), suggesting that at the time of the questionnaire, first-year students had not yet explored this area (only 13.3%), in contrast to third-year students, among whom the identification of usage is widely shared (75.0%).
A comparison of AI use by the types of tasks identified by students and the platforms they use suggests that its application remains predominantly technical in nature, rather than manifesting as a tool for aesthetic or creative exploration. The disciplinary contexts confirm this trend; the most frequently cited subjects are technical in nature, followed by theoretical subjects where AI is used to support writing and research. Its use in traditional artistic practice contexts, such as drawing or painting, remains minimal.

Table 3. Types of tasks for which students identified the use of AI in the Visual Arts.

Academic Year	Types of tasks for which students identified the use of AI in Visual Arts															
	Programming		Generating or Editing Images		Defining Colour Palettes		Generating or Editing Audio		Generating or Editing Video		Generating 3D Models		Researching a Topic		Summarising / Improving Text	
	n=	%	n=	%	n=	%	n=	%	n=	%	n=	%	n=	%	n=	%
Year 1 (n=15)	2	13,30%	10	66,70%	3	20,00%	1	6,70%	3	20,00%	2	13,30%	5	33,30%	1	6,70%
Year 2 (n=22)	10	45,50%	10	45,50%	6	27,30%	1	4,50%	1	4,50%	0	0,00%	3	13,60%	2	9,10%
Year 3 (n=16)	12	75,00%	6	37,50%	7	43,80%	1	6,30%	1	6,30%	3	18,80%	4	25,00%	5	31,30%
Total (n=53)	**24**	**45,30%**	**26**	**49,10%**	**16**	**30,20%**	**3**	**5,70%**	**5**	**9,40%**	**5**	**9,40%**	**12**	**22,60%**	**8**	**15,10%**

4.3 "Practical but Addictive"

To gauge students' perceptions of their preparedness and the impact on the outcomes of AI-based projects, we included a section of questions using a Likert scale and a final open-ended question. Most responses reveal the students' ability to take a critical stance, which tends to be positive, although some contradictions are evident.
As for work efficiency, opinions are mostly distributed around the middle of the scale (43.4%), but if we combine the most optimistic ratings (4 and 5 points), we account for 86.8% of the responses.
Conversely, regarding privacy and data protection, students are divided between the scepticism of the middle of the scale (34%) and the pessimism of the lower ratings (1 and 2 points), accounting for a total of 92.5% of responses.
Students reject reliance on AI for making important decisions (Mo=1) through a significant negative rating (1 and 2 points) of 79.2%, and are unanimously critical in the aesthetic and conceptual domains, with the production of stereotypical images garnering agreement from 66.1% (scores of 4 and 5 with Mo=5) of respondents, suggesting that direct experience of using AI in the visual arts fuels, rather than dampens, critical thinking.
The need for external help is the statement with the most dispersed distribution (32.1% of responses are at points 1 and 2, 15.1% in the middle of the scale and 50.9% at points 4 and 5) and the one that contrasts most with the perceived ease of use (79.3% of students state they have no difficulty in understanding or using AI). This tension between the ease of understanding and using AI and the reliance on support for informed and efficient use is analytically relevant, particularly for pedagogical guidance, as it demonstrates that students feel prepared to perform simple AI-assisted tasks but require guidance for uses involving a higher degree of complexity.

In the open-ended responses, phrases such as “practical but addictive”, “innovative but worrying”, and “useful but destructive” succinctly capture the structural ambivalence that runs through these students’ entire relationship with AI.

5. Discussion

The results of this study show that Art and Multimedia students at the Polytechnic Institute of Viseu, School of Education use AI in a self-directed manner, focusing on a general-purpose platform in its free version, and progressively throughout their course of study.
The most significant finding regarding adoption patterns is that 95.7% of users rely on ChatGPT (61.4% exclusively), with 94.3% using the free version, in line with the findings of the study by Pontes et al [10] for students up to the age of 17. A general-purpose platform accessed in its most limited version does not equate to a diverse ecosystem of creative tools. The diversity of specialised tools for generating or editing images, audio and video, generating 3D models, Programming, and other tasks, remains largely unexplored, indicating that these students do not yet possess AI literacy in the sense defined by Long and Magerko [9]; that is, they do not yet demonstrate the ability to select, evaluate and critically use a diverse range of tools in accordance with specific objectives.
The entry of AI through the technical domain is the second relevant point for this discussion. Programming shows the greatest variation in use across academic years (+464% from the first to the third year), although this is consistent with the development of the curriculum. However, in a course where technique and expression are inseparable, this trajectory is not neutral. The delegation of coding decisions conditions, even if imperceptibly, subsequent creative decisions, a continuity that the post-digital condition helps to frame. In this regard, Conrad, Leijsen & Héritier [2] note that technical and aesthetic tools have never been so closely intertwined, but it is important to recall Latikka et al. [7], who demonstrate that public acceptance of AI is lower the closer it is to the creative decision.
Of relevance to future pedagogical implications is the dissociation between ease of use and informed critical capacity. Most students do not consider AI difficult to use but acknowledge needing guidance for efficient use and express only moderate confidence in choosing platforms.
It is worth highlighting the consistency of the assessment regarding the visual stereotypical nature of AI-generated images, which is consistent with what Siagian et al. [3] identify as the tendency of generative systems to reproduce dominant patterns from training data, thereby undermining the possibility of a pluralistic visual culture. Students are critical and sceptical regarding the adoption of AI in their artistic practice, using it with reservation, an approach that is in line with the recommendations identified as appropriate by the EU AI Act [4] and the European Commission’s Ethical Guidelines [8].

6. Conclusions

This study presented an exploratory analysis of AI adoption among Art and Multimedia students at the Polytechnic Institute of Viseu, School of Education, Portugal, which demonstrated that AI adoption is well established (n=53, corresponding to 58.9% of the total number of students surveyed, n=90) and that it occurs predominantly in a self-directed manner. The progression of students using AI within the Visual Arts, from 41.7% in the first year to 84.2% in the third, documents not an emerging trend, but an ongoing transformation to which the degree programme and the institution will need to find an appropriate response.
The implications are concrete. The institutional response should not focus on the basic introduction of the tools, which students already use, but on creating the conditions for a broader, more critical, and discipline-specific use. This implies explicitly incorporating AI literacy into the curriculum, expanding the technological ecosystem to which students have access, and recognising the scepticism students demonstrate as a pedagogical starting point, not as resistance to be overcome, in line with the priorities, recommendations and international guidelines of the OECD and the EU. The study has limitations that must be acknowledged, starting with the sample being limited to a single institution and level of study, a cross-sectional and descriptive design, and a time frame that the speed of technological evolution quickly renders outdated. Future research would benefit from longitudinal approaches, comparisons across institutional contexts, and intervention studies that evaluate specific pedagogical strategies for AI literacy in arts education.
In summary, what this study suggests is simple yet demanding: before deciding what to teach about AI, it is necessary to listen to what students already know, already do, and already question. It is from this listening that an informed, critical pedagogical strategy can emerge, one that counters the reactive stance of teachers to become proactive.

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Approaches to Pedagogical Innovation: Workshop Developed in an Erasmus Teaching Program in Higher Education

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Abstract

This paper analyzes a pedagogical project developed at the University of Saint-Étienne School of Art and Design (ESADSE), in February 2026, as part of an ERASMUS+ higher education teaching mobility program, and outlines the next stage of this educational initiative based on the results obtained. The project began with meetings with representatives from the host institution's International Relations department, which allowed us to outline the objectives and prepare the in-person week. The implementation of staff mobility programs facilitate the establishment of significant educational exchanges and the strengthening of international cooperation agreements [1]. It's important to emphasize the significance of this type of program and the opportunities created through the implemented mobility: it creates opportunities for cultural exchange, leading to a cross-pollination of ideas from one institution to another. The project involved the implementation of teaching approaches in the delivery of a practical workshop on drawing, character design, and creation. This allowed us to understand how students apply concepts of creative and visual representation when developing a character within a specific framework [2]. The workshop promoted imaginative thinking among the students, by their defining of silhouettes and visually representing personality traits based solely on their understanding of an object as described by a classmate. Further educational opportunities that contributed to this understanding included the presentation of reference materials, monitoring and discussion with individual students, the promotion of communication skills, and the collection of student feedback from a survey. The monitoring and discussion along with the survey enabled the analysis of the contributions regarding the various dimensions and stages implemented. The preparation of the workshop results from teaching practice, based on the various methods and techniques of observation and representation used in the Drawing Curricular Unit (UC) of the Graphic Design degree course at the School of Design (ESD) of the Polytechnic University of Cávado and Ave (IPCA), where research, analysis and drawing stages aim to produce an illustrative representation of a character design with distinctive characteristics. Key stages leading to the creative process were applied, and the results show that the students were able to apply them in the process of creating a character design, thereby developing their critical, creative and visual communication skills. Thus, it was found that the application of specific pedagogical practices, techniques and resources inherent to drawing, as well as assessment strategies, are important analytical tools for the continuous improvement of the pedagogical approaches used in the teaching of drawing.

Keywords: *Pedagogical Approaches, Character Design, Practical Results, Erasmus Teaching Mobility*

1. Introduction

The ERASMUS+ teaching mobility scheme in higher education facilitates significant academic exchange and strengthens international cooperation [1]. Recognizing these benefits, a teaching mobility initiative was proposed to develop a workshop at the University of Saint-Étienne School of Art and Design (ESADSE). In fact, the benefits associated with this type of mobility [3] [4] were successfully fostered, particularly in terms of professional relationships and intercultural connections with partners, which laid the groundwork for future collaboration on teaching programs.
Furthermore, it is important to note that such initiatives can play an important role in institutions' educational plans, in terms of "curricular innovation and the development of study programs, teaching methods, the dissemination of best practices in teaching and research, and learning through

benchmarking"[2] (p. 121) [5, own translation]. These factors prompted us to reflect on and reorganize our teaching practices to enhance our professional development. According to Ivasciuc et al. (2025), faculty exchange programs highlight these key areas: reflective, student-centered teaching; increased student engagement; and the development of directly applicable classroom techniques (pp.4-5) [3]. These elements proved to be extremely motivating and were therefore considered in the planning of the upcoming workshop.

The teaching mobility took place between February 9th and 13th, 2026, successfully fulfilling the project's primary objectives. These goals included strengthening the partnership with the University of Saint-Étienne School of Art and Design through site visits and a formal review of their drawing curriculum. A key focus was observing and understanding the pedagogical approaches used in drawing instruction, in direct collaboration with local faculty. To further our research, the program facilitated an exchange of teaching experiences designed to foster innovation. This included the development of a student project proposal and the opportunity to observe the learning processes firsthand at the host institution.

The project began with online meetings involving representatives from the host institution's International Relations department, providing an opportunity to align objectives and prepare for the onsite visit. During these initial discussions, we outlined the intent to develop an innovative pedagogical approach through a practical character design workshop. This workshop explored how students apply concepts of creative and visual representation and the session's structure was informed by ours prior teaching experience, specifically drawing from Graphic Design degree course at the School of Design (ESD) of the Polytechnic University of Cávado and Ave (IPCA).

This paper presents the theoretical framework of the pedagogical approach, followed by an analysis of the workshop's process, the results obtained, and a discussion of future developments.

2. Pedagogical Approaches for the Workshop

Within drawing courses we teach, pedagogical activities are structured around the core competencies students must acquire: the formal language of drawing, representational techniques, and the communicative strategies essential to a designer's workflow. Accordingly, the curriculum is organized into distinct stages that guide students through foundational observation and representation, transitioning into complex exercises that demand advanced creative and communicative skills. Each student's progression is intentionally structured, ensuring that learning is evidenced by cumulative developmental responses and documented growth over time. Educators must therefore consider a variety of pedagogical strategies to determine which best facilitates the student's learning of the core content. In this regard, we have conducted research on this topic with the aim of analyzing, in a first phase and from a broad perspective, the impact of applying these pedagogical measures on student learning [6]; and, in a second phase, more specifically, on drawing-centered learning in higher education design courses.

In this regard, it is worth noting the study conducted by Suyo-Vega, Fernández-Bedoya, and Meneses-La-Riva (2024), whose primary objective was to "synthesize innovative pedagogical best practices within the university context" (p.1) [7], stating that:

> "*Its importance lies in its direct impact on the quality of university education. These best practices not only enhance the student learning experience but also strengthen the ability of academic institutions to adapt to student needs. By understanding these practices, it is possible to promote and/or improve certain strategies, thus enhancing the quality of higher education*" (p.3) [7].

With a focus on this aspect - improving the students' learning experience [8] - and recognizing that student-centered learning offers benefits "such as intrinsic motivation, personalized learning experiences, and active participation," (p. 352) [9] the goal was to contribute to this effort. Consequently, it was recognized that it is very important to continuously evaluate the pedagogical practices used in teaching drawing and the ways in which they impact the learning process. Turning to more specific content, it is worth mentioning the research by Zimmermann and Coutinho (2020), which proposes an approach to teaching drawing "based on the design process and interdisciplinary relationships"[3] (p. 157) [10, own translation], noting that such an approach involves "thinking of drawing as part of a design process, interconnected with the conception of ideas, communication among the various professionals

[2]Original Text: "Esta influência manifesta-se, segundo os inquiridos, sobretudo ao nível da inovação curricular e dos programas de estudos, dos métodos de ensino praticados, na difusão de boas práticas de ensino e investigação e na aprendizagem por benchmarking".
[3]Original Text: "abordagem de ensino do desenho baseada no processo projetual e relações interdisciplinares"

involved in the process, as well as its relationship with users"[4] (p. 166) [10, own translation]. These new approaches can be explored at various levels, manifesting in drawing exercises that center on a defined "design problem", involving the following creative processes: "Perception, Communication, Investigation, and Action"[5] (p. 167) [10, own translation]. In a way, the presentation of the assignment, along with the analysis of the students' results, illustrates the work process and the learning that took place.

In terms of the practical side of the project – workshop - was instrumental in fostering *student-centered learning* [8, 9], focused on a specific drawing problem to be solved. It is important to note, however, that the "correlation between teaching-learning methodologies and learning outcomes" (p. 121) [8] was analyzed with a view to the content to be covered in the workshop, the intended learning outcomes, and the time allotted for its implementation.

Accordingly, the workshop's work plan included an initial phase of research into how pedagogical dynamics could be structured with a view to the drawing exercise to be carried out by the students, which would involve the illustrative depiction of a character with distinctive traits [2]. In developing critical, creative, and visual communication skills, the challenge focused on depicting an animal figure, followed by an exploration of human expressions adapted to the context of the created figure. The steps were defined with the following learning practices and objectives in mind:

Practice to be implemented	Learning objectives
Present a challenge to be interpreted through drawing	Foster imagination and creativity through drawing Develop analysis of a specific topic
Encourage the practice and exploration of drawing, cutting, and collage	Promote free and capable exploration through practice Develop exploratory practical exercises
Present new questions and steps to be addressed through drawing that encourage research into themes	Encourage students to take the initiative as independent learners to research and solve the problems presented Promote research on a specific topic
Present examples as guiding elements for the drawRaising students' awareness to be developed	Provide a broader understanding of the subject Encourage research and the search for references
Give students space to ask their own questions	Enable students to manage their own autonomy in their projects Allow students to voice their questions for discussion
Promote collaborative and group work	Share their doubts and questions Foster a sense of trust and well-being among students through collaborative sharing and peer support Promote motivation and inclusion for everyone
Create an opportunity for a group drawing exhibition	Provide insight into the group's overall work Create a discussion around the various ideas presented
Collect feedback through an anonymous questionnaire	Create an opportunity to voice students' criticisms Provide an opportunity to indicate perceived difficulty levels Make available the option to be heard and offer suggestions for improvement

3. Practical Development of the Workshop

As mentioned before, the conceptual framework of this workshop is rooted in ours drawing teaching practices. These practices emphasize diverse modes of observation and representation, where research and analysis culminate in the illustrative depiction of characters with distinctive traits. The exercises are designed to be demanding, intensifying investigative practices to push students toward diverse visual solutions. This approach fosters rapid development in sketching while encouraging critical reflection on the character's movement, pose, and expression. While grounded in direct observation, the primary challenge lies in the transition: moving from a static study to representing a character from various angles and situating it within a narrative environment [11].

This staff mobility initiative allowed for an international exchange of methodologies coinciding with ESADSE's Workshop Week. Approximately 60 first-year students participated, including a small cohort of exchange students. The information related to the workshop is organized into the following four chapters:

- 3.1: Introductory Exercise: Tactile perception and memory
- 3.2: Development of Silhouettes: Experimental collage and rapid iteration

[4]Original Text: "pensar o desenho como parte de um processo projetual, interligado à concepção de ideias, à comunicação de diferentes profissionais envolvidos no processo, bem como sua relação com os usuários".
[5] Original Text: "percepção, comunicação, investigação e ação".

- 3.3: The Final Idea - Character Design
- 3.4: Finalization and Feedback

3.1 Introductory Exercise: Tactile Perception and Memory

We started the first day visiting the school and exchange information about the workshop and its demands. The practical session began the next day, in the morning, with a "blind" sensory exercise: a random student was selected to describe an abstract wooden animal sculpture using only the sense of touch. While the teachers assisted in clarifying specific descriptions, the rest of the class attempted to sketch the object based solely on the verbal cues of tactile qualities: weight, shape, and texture.
This phase was made significantly more challenging by the language barrier; as Portuguese instructors teaching a predominantly French-speaking class, some specific technical terms were inevitably lost in translation. However, we viewed this not as a hindrance, but as a pedagogical opportunity. Since the objective was to serve as a foundation for original creation, the "miscommunications" allowed for more unexpected and diverse visual results. Interestingly, despite these linguistic hurdles, the final sketches produced in this first phase bore a striking resemblance to the actual sculpture, demonstrating the power of tactile and visual communication over verbal precision.
This phase forced an exchange between the students' own visual memories and the oral description provided. A primary observation during this stage was the difficulty students faced in translating verbal-tactile information into spatial and volumetric representations on paper (Fig. 1). At the end of the description, the object was revealed, and the students compared their initial sketches with the real piece, noting the divergence between their mental constructs and the actual object.



Fig. 1. The tactile interpretation phase: a student conveys the sculpture's form through touch, while the class translates the oral description into sketches and the first examples of sketches created by the students, based on the oral description provided.

3.2 Development of Silhouettes: Experimental Collage and Rapid Iteration

Building on the initial sketches, the next phase focused on the search for silhouettes based on the description once provided. This took place right after the oral description of the object, still during the morning. In the original curriculum at IPCA, this process spans several weeks; however, for this intensive workshop, the methodology was adapted to favor speed and experimentation.
We introduced a collage-based approach using magazines and scissors. Students were encouraged to gather images (Fig. 2), or even pieces of textured papers (Fig. 3), that echoed their initial shapes to create new, unexpected visual connections. While not all students chose to use collage, some preferring to stick to traditional drawing or a mixture of both (Fig. 3), the technique was proposed as a tool to bypass creative blocks and generate a high volume of silhouettes in a short time. This stage was highly influenced by the experimental approach of Pixar Art Director Deanna Marsigliese [12], focusing on the silhouette as the foundation of character recognition. To conclude the morning session, all work was displayed on the floor for a collective viewing and discussion.

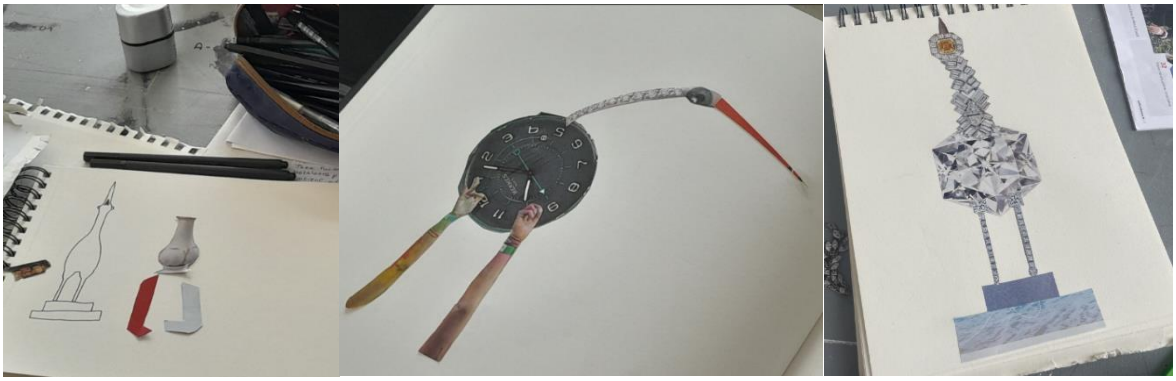


Fig. 2. Representation of the selection of different collages based on the shapes of the previous sketches and examples of collage approach created by the students.



Fig. 3. Example of the mixture of both traditional drawing and other textured paper, and examples of drawing silhouettes experimentation with the work of the students displayed on the floor of all the silhouettes created.

3.3 The Final Idea - Character Design

The final three-hour afternoon session began with a presentation of professional authors and examples of work produced by students at IPCA. This sparked an interesting dialogue regarding institutional differences; notably, ESADSE students mentioned that character design is not typically a core subject in their bachelor's program, which resulted in high engagement and curiosity toward the subject.
Following this, students selected one of their own silhouettes to refine. The objective was to move beyond the abstract shape and develop a finalized look, incorporating specific expressions and a deeper understanding of the character's anatomy. Students were free to use their preferred materials, with most opting for pencil and pen (Fig. 4). The workshop concluded with a final session of sharing the work on the floor, fostering peer-to-peer reflection on the different creative paths taken.



Fig. 4. Development of Expression, final looks of different characters, and Character Development with different poses and expressions, created by the students.

3.4 Finalization and Feedback

To conclude the study, a questionnaire was distributed to 60 participants to evaluate the methodology's impact. However, only 14 students provided detailed responses, around 23%. This lower engagement may be attributed to the post-event distribution of the survey; requesting feedback after the participants had already left proved less effective than anticipated. For future iterations, administering the questionnaire during the final minutes of the workshop would likely yield a higher response rate.
Here is a description of those results of the pedagogical approach: 86% of the students expressed high satisfaction with what they learned, with 93% stating that the level of difficulty was perfectly calibrated to their skills. Notably, despite the language barrier, 100% of respondents found the instructors' explanations to be clear, underscoring the effectiveness of using visual and tactile demonstrations as a universal teaching language.
The experimental "silhouette collage" technique, which was a specific adaptation for this 8-hour format, was particularly well-received, with 71% of the group finding the materials and methodology engaging. The final word clouds highlight that students most valued the "playful" and "experimental" nature of the project.
Furthermore, the data suggests a lasting impact on the students' creative interests:

- 79% of participants expressed a desire to continue developing their characters beyond the workshop.
- Students identified several paths for future development, specifically mentioning animation, 3D modeling, and the exploration of multiple poses and environments.

In conclusion, the feedback confirms that there is a significant interest in Character Design within the ESADSE students. The workshop succeeded in bridging the gap between abstract observation and finalized character illustration, providing students with a new set of tools for rapid iteration and creative expression. Also, the data collected in the questionnaire served as important analytical tools [13], thereby helping to consolidate the practice that had been implemented and encouraging its continuation in the future.
At the conclusion of the workshop, it was clear that the defined steps had facilitated a working process that enabled the achievement of the learning objectives initially set.

4. Future Developments

Building on the results of the initial workshop at ESADSE, the next stage of this initiative aims to transition from a short event focusing on individual drawing techniques toward a comprehensive, structured exchange program. By leveraging the Erasmus+ Blended Intensive Program (BIP) model, we intend to deepen students' drawing practice through a character-driven storytelling project, while maintaining the agile, collaborative nature of international mobility.
Regarding the program's theme, character design serves as an ideal interdisciplinary base for exploring drawing practices. It sits at the intersection of various fields, requiring students to synthesize anatomy, semiotics, narrative structure, and technical software proficiency. This multifaceted nature allows the program to bridge the gap between creative expression and professional design requirements, while having the chance to think about their creative work through differentiated drawing practices.
Regarding the structure, the transition to a BIP model is a pedagogical imperative. As noted by Ivasciuc et al. (2025), faculty and student mobility are critical for fostering reflective teaching and high levels of student engagement [3]. Extending the timeframe through a blended format will allow for a deeper exploration of project-based learning, where cultural exchange and collaborative practice become integral to the design process. This structural shift directly supports institutional goals, as mobility schemes are proven facilitators of curricular innovation and the dissemination of best practices through international benchmarking [1] [5].
Future iterations will maintain the spirit of graphical experimentation while introducing project-based constraints. These will challenge participants to evolve from experimental studies to a more structured design process, where drawing serves as the foundational skill for creativity, ideation, and communication. By introducing guidelines for specific outputs – such as animation, video games, branding, or mascot design – we enable students to explore the various dimensions of character creation, professional design processes, and the impact of characters on society. This extended timeframe allows for a deeper synthesis of creative expression and technical requirements, such as readability and functionality. Consequently, students learn to utilize drawing as an essential tool in their artistic education and future careers.
Ultimately, this program offers a dual benefit: it provides teaching staff with a platform for cross-institutional pedagogical reflection and curriculum development, while offering students an intensive

environment to refine their artistic practice. This model ensures that the initiative remains responsive to both the creative interests of the participants and the evolving professional demands of the design field.

5. Final Considerations

The ERASMUS+ teaching mobility enabled the achievement of the objectives set during the workshop at ESADSE. It is considered that the benefits of this faculty exchange were realized, as evidenced not only by the academic mobility between institutions, but also, above all, by a useful and stimulating reflection on how to employ teaching approaches that promote student learning in a specific subject.
The work process developed during this professional and cultural exchange was extremely important and motivating, contributing to the teachers' professional development and to the establishment of cultural ties that open opportunities for future collaboration on teaching programs.
In the context of mobility, the workshop preparation focused on analyzing pedagogical approaches that could actively contribute to a process with structured learning objectives. Accordingly, the practical component involved several stages, and a work plan was developed that was initially presented during the initial online interactions with the higher education institution and then implemented during the in-person week.
The approach adopted focused particularly on a practical, *student-centered learning process*, with a drawing problem to be solved serving as the starting point. Creativity and the imaginative process were explored through defined stages, beginning with the creation of a character design based on a real object that was only revealed later. The defined practices were implemented with the primary goal of providing students with an experiential, collaborative, discussion-based, and sharing-oriented learning experience, and to assist them in this creative process.
The results show that the students were able to develop this creative and critical reflection process, as documented during the final presentation and in the feedback provided by the students in the questionnaire. Applying the questionnaire was undoubtedly a very useful strategy. However, expanding the questionnaire's reach to more students will be an area for improvement in the next phases of this project.
The aim is to continue this project by expanding the workshop into a Blended Intensive Program. This program will continue to promote interaction among higher education institutions, recognizing that the extended timeframe will allow for a deeper exploration of other contents and will continue to provide teaching staff with a platform for pedagogical reflection, with ongoing analysis of the application and impact of teaching practices on the learning process.

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Curriculum Development

Cultivating Future Engineers: An Integrated Project-based Learning Model in Learning Factory – A Case Study in Chinese Engineering Education

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Abstract

With the rapid development of artificial intelligence and automation technology, the role of information technology and human-machine interaction in modern engineering manufacturing has become increasingly prominent. However, traditional engineering education curricula are mostly limited to single-discipline knowledge transmission, making it difficult to meet the demands of future engineers for composite knowledge, systematic thinking, and innovative capabilities. To address this, we proposed a 3D project-based learning (PBL) model that integrates the "Learning Factory" concept. The model relies on high-fidelity industrial production environments, introduces real engineering constraints, and designs a tiered task structure of "general entry + open challenge." By constructing a 3D teaching framework comprising "Design Thinking – Do (engineering practice) – Develop (iterative extension)," it standardizes and guides the implementation of project directions across different specialties. Currently, this model has been implemented on a university engineering practice teaching platform, covering real industrial projects including intelligent manufacturing production lines, industrial robot material handling, and intelligent audio systems. An analysis of 575 undergraduate students shows that student performance in the project course is positively correlated with prior academic achievement (GPA) but was not fully explained by GPA. This suggests that the model provides students with opportunities to demonstrate abilities through forms of performance beyond conventional academic assessment.

Keywords: *Learning Factory, Engineering Education, Project-Based Learning*

1. Introduction

Manufacturing work is increasingly organized around digital systems, automation, data, and human-machine collaboration. In Industry 4.0 settings, production is connected with cyber-physical systems, networked services, real-time data, and flexible manufacturing, which has pushed engineering programs to reconsider curriculum, laboratory work, and student project activities [5], [8]. Studies of future engineers' skills under Industry 4.0 also suggest that universities need to respond to changing educational and workforce requirements rather than treating digital production as a matter external to engineering education [13]. Discussions of Industry 5.0 extend this pressure by highlighting disciplinary convergence, human-centric design, and human-machine interaction as parts of future engineering work [6].

For undergraduate education, this change requires more than adding new technical content. Future engineers need to handle complex, cross-disciplinary problems and connect engineering knowledge with professional skills and real-world practice [7], [17]. PBL environments have been associated with students' perceived development of teamwork, communication, self-directed learning, and problem solving, which helps explain why generic competences have become a central concern in engineering education [3]. The curriculum problem therefore concerns both what students should know and how students move from problem framing through design, implementation, and iteration.

Project-based learning offers one route for creating such experiences. Reviews of PBL in engineering education show that it has been widely adopted because of its expected contribution to professional knowledge and transferable skills [4]. Recent work also links PBL with real-world skill development when projects are connected with technology, integrated curriculum, multidisciplinary work, simulation, and professional environments [11]. However, a project becomes educationally valuable when the task is well framed, students are supported during implementation, and the learning process connects to broader curriculum goals. This problem becomes sharper in engineering practice courses that contain multiple project modules. PBL practices differ across course, cross-course, curriculum, and project

levels, and recurring challenges appear for students, teachers, and institutions [4]. For a large-scale engineering training platform, the central question is how different projects can share a common learning process across modules.

Multidisciplinary PBL cases make this point more concrete. Collaborative engineering projects involving several specialties require coordination of project phases, partner roles, resources, and assessment of both technical and professional learning [9]. Integrated multidisciplinary PBL cases using Design Thinking also show the need for targeted supervision, trained teaching teams, and attention to the learning process rather than the prototype alone [14]. Teachers need to act as instructional designers and scaffolders; without this, PBL adaptations lose effectiveness [16]. These studies show that cross-disciplinary project learning requires coordinated scaffolding across project assignments.

Learning Factory approaches provide a useful environment for this kind of curriculum problem. Abele et al. [1] describe Learning Factories as systems that combine learning or teaching with production environments and support experiential learning in realistic manufacturing settings. The Heilbronn Learning Factory shows how project-based production engineering can be organized around industrial-like activities while developing professional and social competences [2]. Sackey et al. [15] propose didactic design parameters for an Industry 4.0 Learning Factory. Learning Factory thinking is relevant because it makes production flow, constraints, collaboration, and improvement visible as connected parts of engineering practice.

The present case is situated in a Chinese university engineering training center, where extensive equipment and practice resources serve students from diverse majors, years of study, and technical backgrounds. In this setting, the main challenge is how to organize diverse project directions into a coherent curriculum.

In this paper, we proposed an integrated Learning Factory-based 3D PBL model for a university-wide engineering practice course platform. The model connects different project directions through Design Thinking, Do, and Develop, and is illustrated through industrial production-line and other smart-product projects. Student-level GPA and course-score data are used as a supplementary exploratory analysis of whether project-course performance reflects practical and integrative performance beyond prior academic achievement. The study does not test the causal effectiveness of PBL; its contribution is to explain a curriculum construction logic for large-scale, cross-disciplinary engineering practice education.

2. A Learning Factory-Based 3D PBL Course Platform

The course design examined in this paper starts from an institutional context. The engineering training center serves the whole university, receives students with varied technical backgrounds, and operates a portfolio of short-cycle engineering projects. In this setting, the main curriculum problem is how to organize diverse project directions into one coherent engineering practice platform. The Learning Factory-based 3D PBL model is used for this purpose. It gives different project directions a shared process of Design Thinking, Do, and Develop, while each direction retains its own technical content.

The engineering training center is a university-wide unit that provides engineering literacy and skill development. Engineering training is a required, credit-bearing component with variable load depending on the program: art and management students may take one- or two-credit craft projects; those in engineering typically complete three to five credits, totaling 32 to 160 training hours.

The center serves more than 3,000 students each year, drawn from engineering, science, art, management, and other schools, most participating between the second and third undergraduate years. Some need initial exposure to engineering processes and product thinking; others are ready for circuits, robotics, programming, or system-level design. A curriculum for this setting has to preserve disciplinary differences while maintaining course coherence.

2.1 Project-Based and Learning Factory-Based Curriculum

To make the system more effective, each project is constructed as a project-based engineering practice unit. Most project units carry 1-2 credits. A typical unit is a two-credit, 64-hour project completed over approximately two weeks by teams of three to four students. The expected outputs include a physical artifact or operational system, a technical development report, and a final presentation or defense. These outputs define a complete practice cycle: students interpret a task, plan functions, divide work, learn necessary techniques, implement and test the system, and explain the result.

The project portfolio currently contains around fifteen directions and continues to expand. These directions are grouped into four major clusters: Aerospace and Advanced Systems, Intelligent Systems and Robotics, Smart Devices and Embedded Systems, and AI and Intelligent Perception. Figure 1

presents the full project portfolio. These directions are project tracks within one course platform. They carry distinct technical requirements, but they are governed by a common learning process.
The platform uses a tiered task structure to make this common process workable for mixed-background students. Teachers provide a project theme and a function list divided into basic, advanced, and open-ended functions. Basic functions define the minimum task boundary for all teams. Advanced functions create technical depth. Open-ended functions allow students to add features, optimizations, or product ideas according to interest and capability. This structure accommodates students at different preparation levels.
The Learning Factory approach turns the center's equipment and projects into a curriculum environment. The engineering training center has equipment, practice spaces, embedded systems, robots, manufacturing resources, and intelligent application scenarios. These resources create the material basis for engineering practice, but the old curriculum mainly focus on equipment operation. A student may operate a machine, assemble a component, or complete a procedure without understanding system flow, design constraints, team coordination, or the relation between a technical decision and an application context. In this course platform, Learning Factory logic treats project tasks, tools, constraints, collaboration, testing, and iteration as connected parts of learning. This enables a shared 3D PBL process to guide diverse project directions.

2.2 The 3D PBL Model for Course Organization

The 3D model operates at the course-module level rather than the curriculum-system level. Frameworks such as CDIO guide how entire engineering programs are structured across multiple years. The 3D model addresses a different problem: how to govern the practical process within short-cycle project modules so that diverse directions share a common learning sequence. As shown in **Figure 2**, the model consists of Design Thinking for task entry, Do for implementation under engineering constraints, and Develop for iterative improvement and explanation.
Design Thinking creates the entry into the engineering problem. Students analyze the task context, identify user or application needs, examine requirements, and recognize constraints before implementation begins. Market analysis and application investigation bring scenario, demand, cost, feasibility, safety, product function, and industrial relevance into the task. Students also draw system flowcharts, decompose functions and technologies, and identify the knowledge they need to learn during implementation. This phase gives students with different backgrounds a shared way to interpret the project before they begin using equipment or writing code.
Do turns the planned solution into technical work. Depending on the project direction, students may design circuits, order and solder PCB boards, model product housings, manufacture parts, assemble mechanisms, program controllers, configure industrial robots, integrate sensors, apply AI algorithms, test systems, or debug abnormal behavior. Implementation exposes dependencies among requirements, components, manufacturing conditions, testing environments, and team decisions. Operation is tied back to the functions and constraints identified earlier.
Develop turns first completion into improvement and explanation. Students examine whether the outcome meets the original requirements, identify remaining problems, refine the solution where possible, document the process, and present the result. Teacher guidance and process review continue throughout the project rather than appearing only at final submission. The open-ended function items make iteration necessary because teams often need to adjust goals, improve stability, refine interfaces, or optimize systems after feedback. A partially successful project can still produce learning when students can explain what failed, why it failed, and how the solution could be improved.

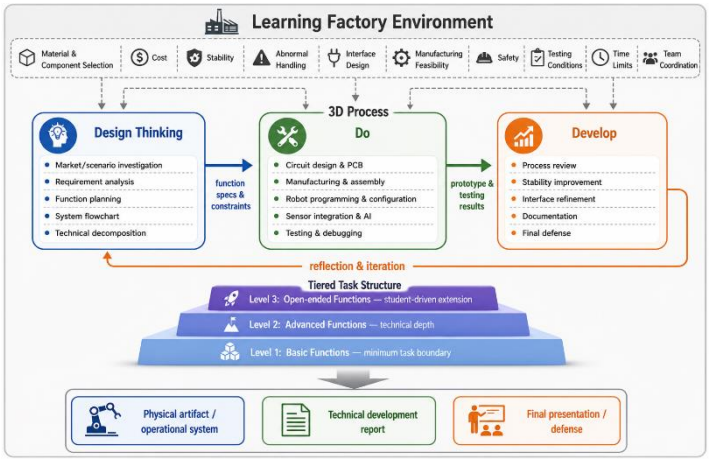


Fig. 2. The integrated Learning Factory-based 3D PBL model

2.3 Course Assessment

The 3D model aligns project directions through process requirements. Design Thinking focuses on problem framing and function planning, Do on implementation and testing, and Develop on review, documentation, and defense. This alignment works for a broad course platform whose project directions are technically diverse.

Assessment follows the same construction logic. In the current course design, project quality acceptance accounts for 40% of the grade, final defense for 20%, technical development report for 20%, and engineering literacy for 20%. Project quality focuses on whether the artifact or system meets required functions and operates with acceptable stability. The report and defense evaluate how students explain design decisions, testing results, and improvement plans. Engineering literacy is assessed through process observations, including collaboration, safety awareness, cost consciousness, and professional conduct.

This assessment structure keeps the platform from being judged only by final product completion. The final artifact is one piece of evidence alongside the broader process of implementation, testing, and iteration. The 3D model thus gives technically diverse project directions a common educational structure.

3. Representative Project Cases

The cases in this section are selected to make two routes of the course platform visible. The industrial robot production-line project represents learning through production flow, equipment coordination, tooling, and process stability. The electronic system and smart product projects represent learning through demand analysis, circuit design, fabrication, debugging, product integration, and presentation. They are representative rather than exhaustive. Other directions in the platform, such as AI vision inspection, intelligent vehicles, UAV autonomous systems, spacecraft design, aircraft power systems, and flapping wing robots, follow the same course logic with different technical content.

3.1 Case 1: Industrial Robot Production-Line Project

The industrial robot production-line project places students in a production-like task environment. The baseline task requires teams to complete a product-oriented process around an aluminum workpiece. Students must connect robot motion with tooling, process sequence, safety, and product quality.

In Design Thinking, students analyze the production task, identify required operations, clarify the handling and processing sequence, and draw a process flowchart. The teacher-provided function list gives all teams a baseline task, while advanced and open-ended items allow teams to go further. One advanced task asks students to adapt a gripper so the robot can hold a writing brush and complete calligraphy strokes. This requires a non-standard end-effector: students must handle grip structure, trajectory control, and tool-center-point setting.

In Do, students work with robot programming environments to configure task paths, test action sequences, adjust coordinates, and debug failures. Typical problems include inaccurate positioning, unstable transfer, unsuitable processing paths, and unsafe motion. In Develop, teams compare the result with original requirements, revise parameters, and present their debugging process in the final report and defense.

3.2 Case 2: Electronic System and Smart Product Development Projects

Electronic system and smart product projects represent another route of the course platform. Examples include oscilloscope systems, smart sockets, and intelligent audio systems. These projects require students to develop a usable device, from demand analysis through circuit design, fabrication, and product assembly.

In Design Thinking, students analyze the use situation and product functions before circuit design begins, clarifying measurement, control, safety, and interface requirements. The function-list structure defines a clear design scope for each project: basic functions set the minimum product behavior, advanced functions add technical depth, and open-ended functions allow teams to improve stability and usability. This structure also supports mixed-background teams, as students can contribute through different roles.

In Do, students use EDA software to design circuits, fabricate PCB boards, solder components, model an enclosure, and integrate the circuit, housing, interface, and program into a product prototype. Implementation problems often appear as noisy signals, unstable measurement, poor circuit-housing fit, or unreliable control. In Develop, teams revise circuits, adjust enclosures, improve stability, and explain remaining limitations in the final defense. The product allows students to discuss trade-offs among function, cost, reliability, and usability.

The two cases show how different project carriers enact the same curriculum construction logic. In both cases, students begin by clarifying the problem and constraints, then implement a system under practical conditions, and finally review, document, and defend their work. This shared process keeps the portfolio coherent.

4. Learning Effects and Exploratory Analysis

Due to data limits, the analysis has a narrower diagnostic purpose. It examines whether the project course gave students opportunities to demonstrate forms of performance that were not fully predicted by prior academic foundation.

GPA serves as the comparison variable because it represents prior academic foundation accumulated through conventional, examination-oriented coursework. If the project course assessed the same type of learning as theory courses, course scores would closely mirror GPA rankings. The analysis uses complete matched records of 575 students from one college who had both GPA and numeric course scores in the project course. Course registration data for a subset of students provided additional boundary indicators, such as self-reported prior foundation and team average GPA. Project directions were not compared because students selected certain project as they wanted.

The 575-student sample shows a high level of course completion and performance. The mean course score was 86.74, with a standard deviation of 7.24 and a median of 88. The score distribution was concentrated in the upper range: 69.7% of students scored 85 or higher, and 39.8% scored 90 or higher. This pattern fits the nature of a guided project-based engineering practice course.

The high-score concentration should be interpreted through the assessment standard. The final grade is based on project quality acceptance, technical development report, defense, and engineering literacy. This process-oriented assessment gives students multiple ways to demonstrate performance through implementation, debugging, collaboration, documentation, and presentation. It also creates a ceiling effect, because final scores alone cannot fully distinguish the quality of design reasoning, teamwork, iteration, or engineering judgment.

4.1 GPA and Course Score Correlation

Prior GPA was positively associated with project-course performance. In the matched sample, the Pearson correlation between GPA and course score was $r = 0.43$, $p < 0.001$, and the Spearman correlation was $rho = 0.49$, $p < 0.001$. A simple linear regression showed that GPA explained 18.9% of the variance in project-course scores, $R^2 = 0.189$. A sensitivity check excluding scores below 60 produced a similar result, $r = 0.42$ and $R^2 = 0.176$. These results show that prior academic achievement matters in the project course.

The same results also show that GPA has limited explanatory power over course performance. If project-course scores were almost entirely determined by GPA, the course would mainly reproduce students' existing academic ranking. The observed pattern shows that GPA is related to performance, but most score variation remains outside the GPA-only model. This result is consistent with the assessment structure of the course, which includes implementation quality, technical reporting, defense, and engineering literacy in addition to task completion.

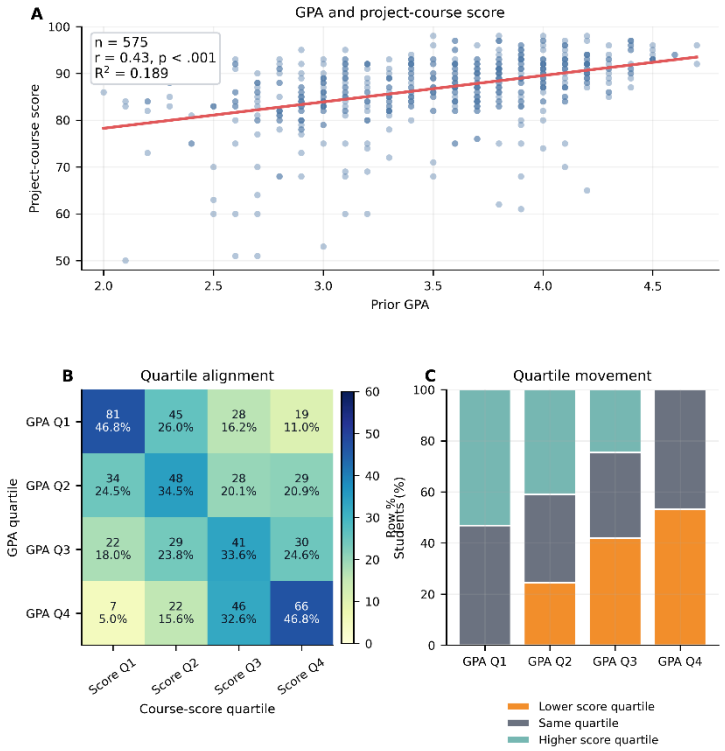


Fig. 3. Association between prior GPA and project-course scores (N = 575). **(a)**Scatterplot of GPA vs. course score with regression line (r = 0.43, R^2 = 0.189); **(b)**Cross-tabulation of GPA quartiles and course-score quartiles. Only 41.0% of students remained in the same quartile; **(c)**Movement from GPA quartile to course-score quartile.

The quartile comparison provides additional descriptive evidence. The cross-tabulation between GPA quartiles and course-score quartiles showed a statistically significant but moderate association, *chi-square* (9, N = 575) = 122.99, $p < 0.001$, *Cramer's* V = 0.27. Only 41.0% of students were in the same GPA and course-score quartile, while 59.0% were placed in a different course-score quartile. Among students in the lowest GPA quartile, 53.2% moved to a higher course-score quartile. This comparison should be read as supplementary because course scores were concentrated in the upper range, but it supports the same bounded interpretation: the course-score distribution was not a one-to-one reproduction of the GPA distribution.

The lower-GPA group provides a concrete view of this performance space. Among students with GPA at or below 3.0, 41.3% obtained project-course scores of 85 or higher, and 14.7% obtained scores of 90 or higher. In the lowest GPA quartile, 46.2% reached 85 or higher and 17.9% reached 90 or higher. A residual check led to a similar interpretation: 60.7% of students in the lowest GPA quartile scored above their GPA-predicted value, and 26.6% exceeded the predicted value by more than five points. The supported claim is narrow: strong project-course performance was not restricted to students with the strongest prior GPA.

The subset of registration data helps define the boundary of this claim. Students who reported prior research experience, competition experience, or related technical preparation had higher project-course scores than those without such records, with an average score of 89.94 compared with 86.56. In the metadata-linked subset, adding self-reported prior foundation increased the explained variance only slightly, from 21.8% to 23.6%. Team average GPA was also associated with course score, r = 0.43, $p <$ 0.001. These results confirm that background experience and team conditions still matter in an open-ended engineering practice environment.

The exploratory analysis supports a bounded interpretation of the curriculum: the project course gave students different opportunities to demonstrate performance. This interpretation is supported by the fact that project-course performance was associated with prior GPA but had substantial unexplained variance. The course-score distribution partly departed from GPA-based academic ranking, and many lower-GPA students achieved strong or above-predicted project-course outcomes. These findings are consistent with the idea that the course assessed practical, collaborative, and process-oriented work in addition to prior academic achievement.

5. Discussion and Conclusion

The Chinese engineering training center context gives the model a specific educational meaning. Such centers often function as university-wide platforms rather than as ordinary course units. They may have substantial hardware resources, manufacturing spaces, robots, embedded systems, and digital equipment, while also serving large numbers of students from different schools. This institutional form creates a tension. The center has the resources to provide rich engineering practice, but its students vary widely in background, motivation, professional goals, and technical preparation.

The integrated 3D PBL model addresses this tension by combining accessibility with challenge. Basic functions give all teams a feasible entry point. Advanced functions provide technical depth. Open-ended functions allow students with stronger preparation or clearer interests to extend the project. Teacher guidance and process review prevent the course from becoming an unguided competition in which only previously prepared students can benefit. The Learning Factory environment keeps the work connected to engineering constraints.

The model also fits the cross-disciplinary nature of the platform. Students from non-engineering or less technically intensive programs may complete different levels of technical exploration compared with students from automation, computer science, or mechanical engineering. They can still participate meaningfully through user scenario analysis, product design, process planning, documentation, presentation, or market-oriented investigation. Students with stronger engineering backgrounds can engage more deeply with control, circuit design, programming, AI, manufacturing, or system integration. The shared process allows both forms of participation to remain within one course system.

Several limitations should be made explicit. The study is based on a single university engineering training center, so the model should be understood as a context-rich case rather than a universally validated framework. The quantitative evidence is exploratory and does not include a comparison group, pre-post competence measures, or validated scales. The current analysis also does not directly measure the competencies that the model targets, such as systems thinking, interdisciplinary integration, or innovation. These require more direct evidence aligned with the 3D process in future work.

Within the limits of a single-case exploratory design, this study offers a practical contribution to engineering education. The integrated Learning Factory-based 3D PBL model provides a curriculum mechanism for making project-based learning coherent, guided, and expandable in a large-scale practice platform. By aligning problem framing, implementation, and iterative development, the model helps diverse students encounter engineering work as a process of reasoning, making, testing, improving.

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Perceptions of Secondary Stage Students of the Role of the School Library in the Development of Reading and Writing Skills in Kuwait

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Abstract

This study explores the perceptions of the role of the school library in supporting reading and writing development among secondary stage students in Kuwait. Employing a quantitative research method, this study uses a structured questionnaire to collect data from secondary stage students regarding their views, experiences, and attitudes toward the role of the school library in supporting their reading and writing skills development. This research contributes to improve reading and writing skills development among students in the secondary stage and to enhance understanding of the educational role of the school library. Moreover, the study places the school library within the broader educational context as a learning environment which supports literacy development and students' engagement. By highlighting students' perceptions, this research sheds a light on how school libraries are viewed not only as resource centers but also as potential active agents in the learning process, academic growth, and skill development. The findings provide insights that may inform educators, school leaders, and policy makers about the necessity of developing curriculum that integrate the school library effectively within the secondary stage education system, in particular reading and writing instruction. This research also offers implications for improving library practices and promoting effective usage of the school library as a crucial part of the learning process.

Keywords: *school libraries; reading skills; writing skills; secondary stage students; Kuwait*

1. Introduction

Reading and writing are the cornerstone of lifelong learning, personal development, and academic progress. They are not merely about decoding and recognizing words, but also involve critical thinking, understanding, and communication skills that enable the modern student to navigate the learning environment. In Kuwait, enhancing reading and writing remains an ongoing challenge, especially among secondary stage students, despite ongoing curriculum modifications. Many students still struggle to acquire the essential literacy skills needed for lifelong learning and academic success.

In an ever-changing technological world and an increasing flow of information, the importance of solid reading and writing skills cannot be overstated. Strong literacy skills influence students' educational progress and personal development as they shape academic trajectories, professional opportunities, and lifelong learning goals. These skills are also recognized as critical factors for sustainable development, which makes their cultivation a central priority for educational systems worldwide. In Kuwait, this challenge is compounded by diverse student backgrounds, varying levels of learning skills, and unequal access to learning resources, all of which create additional barriers to developing robust reading and writing competencies.

School libraries, rich in educational resources and potential learning support, have been neglected and underutilized over the years. This raises an essential question about how students perceive the contribution of school libraries to their reading and writing development. This study therefore aims to explore secondary stage students' perceptions of the role of the school library in supporting reading and writing skills development.

2. Significance of the Study

The significance of this study lies in its potential to bridge a key gap in understanding how school libraries are perceived to contribute to the enhancement of students' reading and writing skills within Kuwait's secondary education system. By exploring students' perceptions, the research highlights the educational value of libraries not only as repositories of knowledge but also as dynamic learning environments that can cultivate curiosity, critical thinking, and academic competence.

3. Problem Statement

Enhancing reading and writing skills among students in Kuwait, particularly secondary stage students, is an ongoing challenge. Although the Ministry of Education has implemented curriculum improvements, many students still struggle with these skills, especially as they are necessary for lifelong learning. Diverse student backgrounds and unequal access to educational resources have contributed to the complexity of skills development in Kuwaiti schools.

School libraries, despite their rich resources, are often neglected and underutilized. Over the years, the role of the school library in supporting the curriculum has diminished, raising a crucial question: how do secondary stage students perceive the role of school libraries in the development of their reading and writing skills? The research aims to explore these perceptions and highlight the perceived significance of library resources in enhancing reading and writing skills development.

4. Literature Review

Benefiting from school libraries in supporting the curriculum is widely recognized as a vital step toward enhancing students' literacy skills [1] [2]. Research emphasizes that the professional role, leadership, and self-efficacy of school librarians strongly influence students' information literacy because librarians guide them in locating, evaluating, and using information effectively [3] [1]. Studies in Kuwait similarly indicate that school librarians' practices—when aligned with curriculum goals and supported by adequate training—contribute to improved information literacy and academic growth through targeted activities and instructional support [2]. These findings position the school library as more than a repository of books; it is a structured learning environment that can scaffold students' engagement with reading and writing tasks [1] [2].

A substantial body of international research shows that well-resourced and professionally staffed school library programs are associated with higher levels of student achievement and reading motivation [4] [5] [7]. When libraries receive sufficient funding, maintain diverse and up-to-date collections, and employ qualified librarians, students tend to display stronger reading outcomes, higher test scores, and more positive attitudes toward reading [7] [8] [9]. Large-scale studies from multiple U.S. states and other countries report that students in schools with effective library programs and trained staff often outperform peers in schools where such provision is weak or absent [4] [7] [10] [12]. These effects are frequently observed even after controlling for socioeconomic factors, suggesting that the quality of the school library program can make an independent contribution to literacy outcomes [7] [10] [12].

The characteristics of effective school libraries are consistently highlighted across the literature. Key features include the presence of a full-time qualified librarian, a rich and varied print and digital collection, access to technology, and systematic collaboration between librarians and classroom teachers [4] [7] [8]. Conceptual work on school libraries describes them as "dynamic agents of learning," arguing that their informational infrastructure supports deep learning when it is embedded in classroom instruction rather than treated as an add-on [13]. In such models, librarians co-design lessons, teach information literacy, and provide ongoing guidance on research and writing tasks, thereby strengthening students' independent learning skills [13] [14].

Information literacy frameworks further underline the central role of school libraries in teaching students to locate, evaluate, and ethically use information [1]. Evidence shows that many students rely heavily on search engines and rarely apply critical evaluation criteria, which underscores the need for explicit instruction in information and digital literacy [15]. School libraries that integrate structured information literacy programs into the curriculum help address these gaps by offering guided practice in evaluating sources, using digital platforms, and citing materials appropriately [1] [13].

The literature also establishes a close link between reading proficiency, academic success, and lifelong learning, with poor reading skills placing students at continued risk of underachievement [6]. School library programs that provide diverse, age-appropriate materials, promote both curricular reading and reading for pleasure, and ensure equitable access to books can mitigate these risks [7] [9]. Time spent reading, supported by library resources, has been shown to improve vocabulary, writing style, grammatical competence, and spelling, particularly for students who may not have alternative access to books at home [9].

Finally, collaborative relationships between librarians and teachers emerge as a recurring factor in successful library programs [8] [13] [14]. When librarians are recognized as instructional partners, and when library activities are integrated into classroom assignments, school libraries are more likely to contribute meaningfully to students' reading and writing development [7] [8] [13]. These international

and local findings provide an important foundation for examining how Kuwaiti secondary school libraries can function as active agents in promoting literacy skills and supporting quality education.

5. Methodology

5.1 Research Design

This study uses a quantitative research design to explore students' perceptions of the school library's role in developing reading and writing skills through a structured questionnaire. The questionnaire was selected for its ability to gather data from a larger group efficiently and to provide an accurate representation of participants' views and experiences.

5.2 Data Collection

Data were collected using a structured questionnaire distributed to students through the online learning management system MyU. Responses were recorded electronically through Google Forms. The questionnaire included closed-ended and Likert-scale items, and students were informed of the purpose of the study, assured of anonymity, and participation was voluntary.

5.3 Participants and Sampling

The participants consisted of secondary school students enrolled in grades 10, 11, and 12 at one selected secondary school. The school was chosen based on accessibility and institutional cooperation. A total of 62 students completed and submitted the questionnaire and constituted the final sample. A convenience sampling technique was employed due to accessibility and feasibility within the research timeframe.

5.4 Instrument

The data collection instrument was a structured electronic questionnaire created using Google Forms. It included sections on demographic information, school library habits, perceptions of the school library, reading skill support, writing skill support, and one open-ended question for further comments. The questionnaire items were adapted from established instruments used in studies of school library impact and collaboration. They were reviewed to ensure clarity and relevance to the Kuwaiti secondary education context and organized into sections measuring students' school library habits, perceptions of library resources, and perceived support for reading and writing skills [4] [5] [8].

6. Findings

6.1 Demographic Information

Table 1. Demographic Information

		Frequency (n)	Percentage (%)
Gender	Female Male	100%	
Grade	10	20	32.3%
	11 Arts Track	18	29%
	11 Science Track	17	27.4%
	12 Arts Track	-	-
	12 Science Track	7	11.3%

All participants were female students. In terms of grade level, 32.3% were from grade 10, 29% from grade 11 arts track, 27.4% from grade 11 science track, and 11.3% from grade 12 science track, while there were no participants from grade 12 arts track.

6.2 School Library Habits

Table 2. School Library Habits

Statement	Frequency (n)		Percentage (%)
How often do you visit the school library?	Daily	-	-
	Several times a week	8	12.9%
	Once a week	4	6.5%
	Several Times a month	4	6.5%
	Rarely	25	40.3%
	Never	21	33.9%
On average, how much time do you spend in the school library per visit?	Less than 15 minutes	37	59.7%
	From 15 to 30 minutes	23	37.1%
	From 30 to 60 minutes	2	3.2%
	More than an hour	-	-
What is the primary reason for visiting the school library?	Reading for fun	22	35.5%
	Research and Academic Work	11	17.7%
	Use of library computers	3	4.8%
	Attend a library event	4	6.5%
	Meet friends/Socialise	17	27.4%
	other	5	8.1%
Did you visit the school library this academic term?	Yes	42	67.7%
	No	20	32.3%
How do you usually hear about library activities or new resources?	School Advertisements	23	37.1%
	Teachers	12	19.4%
	Friends	13	21%
	Library Staff	1	1.6%
	Posters	13	21%
Do you have a library membership/card?	Yes	1	1.6%
	No	61	98.4%

The findings indicate limited school library use. While 12.9% of students visited the school library several times a week, 40.3% reported visiting rarely and 33.9% reported never visiting. Most students spent less than 15 minutes per visit. Reading for fun was one of the most common reasons for visiting the library, but nearly all students reported not having a library membership card.

6.3 Perceptions of the School Library

Table 3. Perceptions of the School Library

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The school library provides activities or programs that contribute to my literary development	-	11.3%	29%	41.9%	17.7%
The school library offers learning materials and resources that support my academic success	3.2%	1.6%	33.9%	41.9%	19.4%
The school library staff provide assistance that helps students feel supported and included.	1.6%	-	21%	51.6%	25.8%
I regularly use the school library for reading or writing-related activities.	4.8%	14.5%	33.9%	30.6%	16.1%
The library's resources are up-to-date and relevant for developing reading and writing skills.	4.8%	12.9%	24.2%	38.7%	19.4%

Students generally expressed positive views about the school library's resources, staff support, and contribution to academic success. Many agreed that the library provides activities and materials that support literacy development and that staff assistance helps students feel supported and included. However, regular use of the library for reading or writing-related activities was weaker than these positive perceptions.

6.4 Reading Skill Support

Table 4. Reading Skill Support

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The school library provides effective resources (such as books, reading lists, or digital materials) that help improve my reading skills.	4.8%	6.5%	30.6%	43.5%	14.5%
The school library organizes reading programs or events that motivate me to read more often.	6.5%	12.9%	19.4%	35.5%	25.8%
The school library provides quiet and comfortable spaces suitable for focused reading.	-	6.5%	16.1%	38.7%	38.7%
The school library recommends books that match my reading level and interests.	1.6%	4.8%	25.8%	40.3%	27.4%
The school library provides access to digital reading platforms (e.g., e-books or audiobooks) that support my reading practice.	6.5%	14.5%	25.8%	35.5%	17.7%
The school library staff assist me in finding reading materials that support classroom learning.	-	11.3%	32.3%	40.3%	16.1%
The school library displays reading materials that promote a reading culture among students.	3.2%	4.8%	32.3%	45.2%	14.5%

Students' perceptions of the library's contribution to reading development were largely positive. Many agreed that the library provides effective reading resources, quiet and comfortable spaces, suitable recommendations, digital reading platforms, and materials that promote a reading culture among students.

6.5 Writing Skill Support

Table 5. Writing Skill Support

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The school library offers reference materials (e.g., grammar guides, writing manuals) that help me improve my writing skills.	1.6%	8.1%	30.6%	46.8%	12.9%
The school library provides access to digital tools or research materials that support academic writing.	1.6%	6.5%	37.1%	41.9%	12.9%
The library staff assist students in locating materials that strengthen research and writing assignments.	1.6%	3.2%	33.9%	46.8%	14.5%
The school library organizes workshops or sessions focused on improving writing skills.	6.5%	11.3%	22.6%	43.5%	16.1%
The library provides access to citation tools and writing software (e.g., Grammarly, Turnitin, etc.).	4.8%	6.5%	38.7%	37.1%	12.9%
The library offers examples of high-quality student essays or research projects for guidance.	1.6%	8.1%	33.9%	37.1%	19.4%
The school library collaborates with teachers to support writing assignments and projects.	3.2%	1.6%	29%	38.7%	27.4%

Students also reported generally positive perceptions of the library's role in supporting writing skills. Many agreed that the library offers reference materials, digital tools, staff assistance, workshops, examples of student work, and collaboration with teachers to support writing assignments and projects. Nevertheless, writing-related support appeared less visible in practice than reading-related support.

7. Discussion

This study shows a clear contrast between students' positive perceptions of the school library and their low level of actual use. Students generally recognized the value of the library's resources, spaces, and staff support, especially for reading development, but many did not visit the library regularly. This suggests that the availability of resources alone does not guarantee regular use or strong engagement. The very low rate of library membership and the limited frequency of visits indicate a weak library culture within the selected school. This implies that, despite the presence of resources and supportive staff, students may not perceive the library as an integral part of their everyday learning practices. The disconnect between positive attitudes and actual usage mirrors international findings that passive provision of resources alone does not foster engagement; rather, integration into classroom activities, active promotion, and clear alignment with curriculum tasks are needed to encourage regular library use.

The findings also indicate that reading support appears stronger and more visible than writing support. Responses to the open-ended question suggest that students want dedicated library periods, more workshops, more active promotion, and a wider variety of books and resources. These suggestions point to the need for stronger integration of school libraries into classroom learning and daily school life, where librarians and teachers work together to design activities that support both reading and writing development.

8. Conclusion

This research investigated secondary stage students' perceptions of the role of school libraries in developing reading and writing skills in Kuwait. Using a questionnaire with 62 female students from one selected secondary stage school, the study found that although students recognize the importance of

school libraries, actual usage remains limited. The findings highlight the need for stronger promotion, better visibility of services, and closer collaboration between librarians and teachers.
Future initiatives should focus on positioning the school library as an active part of the curriculum rather than a supplementary facility. This can be supported by integrating library resources into classroom activities, promoting regular library visits, strengthening staff support, and improving access to resources for both reading and writing.
For educational professionals, the findings underscore the importance of treating the school library as a collaborative partner in teaching rather than an optional add-on. Strengthening collaboration between librarians and teachers, investing in digital and print resources that support both reading and writing, and promoting structured programs such as dedicated library periods, workshops, and reading or writing competitions can help transform the library into an active learning hub. For policymakers and school leaders, the results highlight the value of funding, staffing, and policy frameworks that support sustained library-based literacy initiatives in Kuwaiti secondary schools.

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Incentivizing Continuous Learning to Master New Skills and Knowledge in Engineering Undergraduate Students: Collaboration Strategy and Performance Assessment

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Abstract

The current Educational Model of the Tecnologico de Monterrey frames teaching-learning strategies that ensure the development of competencies at the end of the student's professional training process. These competencies are key elements to perform and adapt head on work and social scenarios currently unforeseen. On this line, the present work integrates results of an experience at a specific level, which promoted the development of transversal competencies according to the expected attributes to crown the graduation profile in engineering. With emphasis on the knowledge-skills guiding axis, an activity was designed collegially, requiring addressing content, solving a real problem, and integrating a performance evaluation system to manage one's own learning. The deployment involved active learning strategy linked to a collaborative work system. The essential elements of the methodology were the definition of roles, the setting of common objectives, teamwork and its processing, as well as recognizing and generating a positive interdependence with a high level of responsibility and commitment on the part of the student. The obtained results were: approximate a global process developing activities typical of professional practice; confirm the degree of progress in skills such as problem solving, evaluation of components and own reasoning; and evaluate and provide feedback on the process to project it into equivalent scenarios.

Keywords: *Higher education, Lifelong learning, Active Learning, Collaboration, Transversal Competencies, Student performance*

1. Introduction

The accelerated growth of today's societies demands the inclusion of professionals who solve complex problems and drive progress and transformation towards a common good [1]. Thus, an unavoidable change in training processes is expected from education that privileges the development of strategic competencies and, in turn, promotes reflection on the need to sustain the development of professional and personal competencies, it is to say, encourages lifelong learning [2]. Under this premise, in the Educational Model of the Tecnologico de Monterrey, which is based on competencies [3], strategies and training experiences contextualized in a reality for ensuring, the capacity to act in the face of challenges of a changing and uncertain world, we performed an opportune intervention for foresting lifelong learning framed on the active learning linked to a collaborative work system with engineering students enrolled in the first year of the exploration stage, 2022 – 2023.

2. Development

2.1 Theoretical Framework

In today's societies, there are great challenges to create value and prosper, in order to achieve the well-being of people [4], which shows the need for greater collaboration among actors, distinguishing their different development and leadership capacities [5]. Regarding the insertion of professionals with a greater capacity for action, adaptation, interaction and reflection for decision-making [6], it entails a significant condition of comprehensive training contextualized in real experiences and under the framework of learning to learn, learning to do, learning to live together and learning to be [7]. Therefore, it is essential to distinguish vital functions of responsibility, leadership and resilience, both at the individual and community level, that is, with individual capacities and social competencies [8].

Lifelong learning is a broad term that refers to continuous learning throughout a person's life. Organizations like the European Commission, UNESCO, and the OECD agree that it involves the ongoing development of knowledge, skills, and competencies [9]. A literature analysis allows to identify the skills that are considered for lifelong learning, these may be classified as cognitive, meta-cognitive and social-emotional skills. The first group contemplates problem solving, critical thinking, information literacy and research skills; the second group has self-direction and lifelong learning orientation, reflection, learning regulation and planning (stepwise processing, self-testing), learning management; and the third group are teamwork and collaboration, oral and written communication, empathy and personal agency, networking and social support [10, 11, 12, 13, 14]. Particularly, in engineering students, the development of lifelong learning skills acquires essential importance due to rapid technological change, globalization, and evolving labor market demands. Studies have already emphasized that engineering graduates must develop not only technical expertise but also transferable skills [15,16]. Literature research on the topic since 2019 focuses on the idea that lifelong learning enables engineering students to continuously improve their competencies, update their knowledge, and remain professionally relevant throughout their careers [17]. Under this panorama, it is undeniable that higher education institutions have a fundamental role in the integration of experiences for the formation of those skills and in preparing them to adapt to future challenges.The framework of the Tec21 Educational Model of the Tecnológico de Monterrey (MTec21) defines for its students the development of transversal and disciplinary competencies for their comprehensive training (**Figure 1**); these transversal competencies relate the student to their environment [18].
The present work was based on challenge-based learning (CBL) and collaborative learning (CL), integrating a performance evaluation system to manage one's own learning [19, 20].

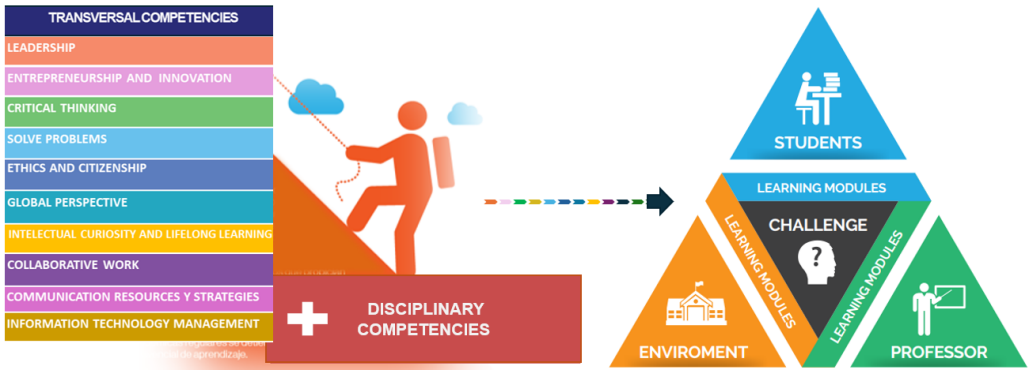


Fig. 1. Main transversal competencies and their linking to disciplinary competences in Tec21 Model

For the development of these competencies, four methodological actions are planned that allow the development of competencies to be organized and put into practice according to the level and moment in which the student is:

1. Analyze the competencies and their impact with other competencies in the study plan;
2. Plan and coordinate the development of problems to be solved in order to achieve mastery of the competencies established in a training unit;
3. Select the most appropriate ways to promote the learning of conceptual, procedural and attitudinal content in an integrated manner;
4. Use a varied selection of teaching strategies [21].

2.2 Innovation Description

In terms of the TEC21 Educational Model, an activity was designed that addresses the need for changes in training spaces to promote a high capacity for skill development and application of knowledge, which integrates elements of an active process of collaboration and life experience under the guiding axis of knowledge mastery-skill development, as well as the curricular definition that leads the student to complete their comprehensive training process based on transversal (TC) and disciplinary (DC) competencies. For the planning of the exercise, focused on the student and the level of competency development, a base collaboration group responsible for the deployment, monitoring and evaluation was integrated, made up of teachers linked to the course of training units or UF (Spanish acronym for Unidades de Formación), effectiveness staff and student mentoring [22].

The activity aimed at engineering programs (2019 plans) of the Tecnológico de Monterrey, established in the first and second periods, scheduled in the second academic semester February-June of 2023, allowing the inclusion of students, 28 and 30, enrolled in the Bioengineering and Chemical Processes, Innovation and Transformation, and Applied Sciences avenues.

Essential parts

Competencies

- Identification of the level of scope and linked UF, **Figure 2.**

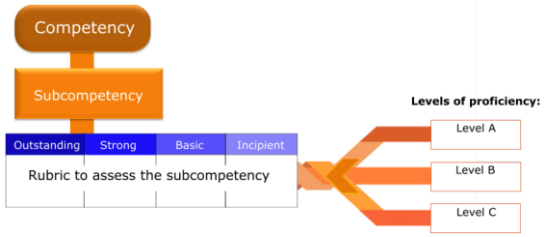


Fig. 2. Context of achievement levels when competency is assessed in a UF

- Attitudinal and procedural knowledge that precedes, student's own conditions, progress-moment in the study plan.

Didactic strategy and auxiliary techniques:

- Active learning, linked to reality and Collaborative Learning (CL) to maximize individual and group learning; both focused on seeking to develop skills in challenge resolution (CBL), openness to dialogue, interaction and reflection.
- Training in key elements of the base academic group, MTec21 Didactics.
- Integration of collaborative work teams.

Significant spaces for collaboration:

- Classroom and laboratories for individual activities that are integrated into teamwork, with elements of a work context (problems, definition of common objectives, leadership, self-management to reach completion and delivery).

Procedural and attitudinal content

- Modularization of theoretical-practical content.
- Definition of stages for solving the problem
- Guiding conditions to know the criteria for participation and development of the activity.

Evaluation:

- Evaluation committee made up of the group of teachers.
- Observation rubric, measurement of the competencies by individually evaluating evidence based on key actions, **Table 1.**

Table 1. Example of bases for the structuration of an observation rubric

Competencies		Quality criteria
Correctly solves problems of reality, based on precisely delimiting the problem and the intervening variables, selecting and strategically applying the appropriate methods and techniques to analyze information, and correctly interpreting. Integrate the results to propose the solution.	Solves the questions of reality	correctly
	Defines the problem and the variables	with precision
	Selects and apply methods and techniques	relevant
	Interpret the results	in integrated way

The evaluation considers general observation rubrics and survey. The general observation rubrics measures the progress on the challenge, content, self- and peer-assessment (**Table 2**) while survey supports the final stage of evaluation and reflection. As indicated in **Table 2**, the level of achievement is defined in four terms: Outstanding 100 (greater than or equal to 95), Solid 88 (81-94), Basic 75 (70-80) and Incipient 55 (Less than or equal to 69).

Table 2. Observation rubric example

Nivel	Outsanding	Solid	Basic	Incipient
	100	88	75	55
Generic Descriptor	Shows *optimal performance* , corresponding in its totality (or almost) to the demands of the sub-competencies, aligned with the correct defined for the evidence.	Shows *appropriate performance* , corresponding mainly to the demands of the sub-competencies, aligned with the correct defined for the evidence.	Shows *acceptable performance* and manages to meet the minimum demands of the sub-competencies, aligned with the context defined for the evidence.	Shows poor *performance* and therefore fails to meet the demands of the sub-competencies, aligned with the correct defined for the evidence.

As technological tools, Canvas platform, Excel and Mentímeter were used.

2.3 Implementation of the Innovation

The academic group in charge, previously trained, participated in a differentiated way, assuming various roles: action research, designers, facilitators, mentors, tutors, and evaluators. The mentor and director facilitated interviews and information that allowed the evaluation of scenarios of action by the students, for example risk factors. It should be noted that, due to an agreement on the handling of confidential information, some data and real names of people are omitted in this report.
The competencies to be developed were identified, which are conducive to the graduate profile of the engineering careers (Chemistry, Biotechnology, Sustainable Development, Industrial Engineering, Data Science Engineering, Mechanics Engineering and Agrochemistry).
The participating UFs were: F1010B-Application of thermodynamics in process engineering (24 students) and F1011B-Analysis of electrical systems in process engineering (30 students). By delimiting the work's extension, an example of identified TCs is shown in **Table 3.**

Table 3. Example of TCs in the UF impacting the graduate profile

Competencies in UF	Level of achievement	Graduate profil competencies
Solves problems and questions about reality, based on valid and reliable methodologies.	A	Solve problems
Evaluates the solidity of one's own and others' reasoning, based on the identification of fallacies and contradictions, which allows them to form their own judgment regarding a situation and problem.	A	Critical thinking
Evaluates various information technologies, with openness in the search and implementation of relevant alternatives in the transformation of professional practice	A	Management of information technologies

To justify the expected levels of achievement in the focus groups, two actions were carried out:

- The preparation in knowledge and skills of previous UFs (F1002B Period 1: Process modeling and F1003B Period 2: Conservation laws in process engineering) was recognized (**Tables 4** and **5),** beginning on the exploration stage.

Table 4. Competencies and achievement level at UF, first and second semester

Stage: Exploration. Disciplinary Competencies			
UF/Disciplinary Competencies	**Substantiates**	**Solve Problems**	**Period**
F1002B	Explains (A)	Make decisions (A)	1/2nd
F1003B	Demonstrate (A)	Implement actions (A)	1/3d
F1010B	Explains (B)	Evaluate components (A)	2/1st
F1011B		Evaluate components (A)	1/2nd
		Generate proposals (A)	

Table 5. Competencies and achievement level at UF, first and second semester

Stage: Exploration. Transversal Competencies				
UF/ Sub Competencies	**Reasoning**	**Comunication**	**Digital Transformation**	**Semester/ Period**
F1002B	Critical Thinking Solves question problems (A)	Written language (A)		1/2nd
F1003B	Scientific Thinking Solves question problems (A)	Written language (A)		1/3d
F1010B			Evaluate and look for alternatives (A)	2/1st
F1011B	Scientific Thinking Solves question problems (A) Scientific Thinking Evaluate your own reasoning (A)			2/2nd

- A general overview of risk and protection factors was provided for review, the measurement of which is derived, in terms of High, Normal and Low levels, from the application of a survey upon admission, for example:
  - *Resilience (R). Adaptive ability to get ahead or recover from a stressful situation.*
  - *Comprehensive well-being (CWB). Social and psychological prosperity, taking an interest in one's activities, feelings and emotions.*
  - *Psychological flexibility (PF). Positive evaluation of emotions, coping with feelings and emotions.*
  - *Goal orientation (GO). Setting goals and having the motivation to achieve them.*
  - *Support networks (SN). Perceiving that they have the support of peers, family, tutors and mentors*.

The percentage of students in the interest groups that reflected a Low level in the different protection factors were *R*: 29 %; *CWB*: 14 %; *PF*: 7 %; *GO*: 7 %. Only *SN* showed a response at High and Normal levels.

Then, the workspaces and theoretical-practical content were established by the academic team defining:

- Classrooms for interaction and laboratories for experimentation.
- Modularization and programming oof dosed knowledge during the process of solving the challenge (corresponding to Mathematics, Computing and Physics in a greater concentration).
- Multidisciplinary teams of 3-4 members.
- Active process that integrated the elements of collaboration to solve a challenge, and programming of the theoretical-experimental progress, of the time period corresponding to 5 weeks (**Figure 3**).

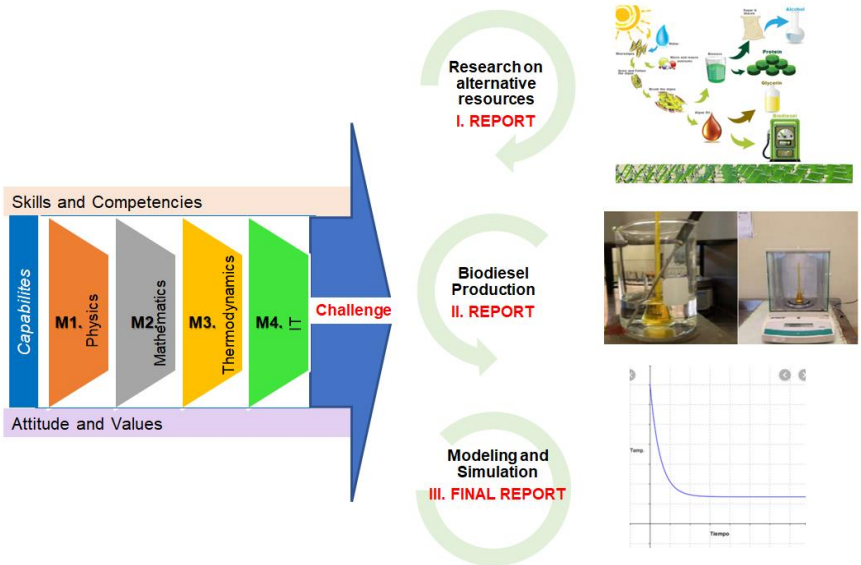


Fig. 3. Example of modularization of content in a UF

Example of challenge: *Modeling and Simulation of the charge and discharge processes of an RC circuit powered with an alternating voltage source*

Objective: Design and build an electrochemical cell system using natural substrates that supplies voltage to an RC circuit and simulate its charge and discharge process in Matlab.

The performance measurement corresponding to a level of competency achievement was carried out based on the observation guides and is exemplified in **Table 6**, with an individual measurement.

Table 6. Example of individual result obtained from the observation rubric

Student A	Outstanding	Strong	Basic	Incipient	Did not provide evidence
	4	3	2	1	0
SEG0502 Solves problems and questions of reality, based on valid and reliable methodologies					
SEG0502	Correctly solve the questions of reality, starting from precisely defining the problem and the intervening variables, selecting and strategically applying the relevant methods and techniques for information analysis, as well as correctly interpreting the results to propose the solution.	Correctly solve the questions of reality, starting by clearly defining the problem and the intervening variables, by strategically selecting and applying the relevant methods and techniques for information analysis, as well as by correctly interpreting the results to propose the solution.	Partially solves the questions of reality, by defining the problem and/or the intervening variables with imprecisions, by selecting and applying the relevant methods and techniques for information analysis inconsistently, as well as by interpreting the results in an acceptable way to propose the solution.	Incorrectly solves the questions of reality, by vaguely delineating the problem and/or the intervening variables, by selecting and applying the relevant methods and techniques with errors for the analysis of information, or by misinterpreting the results to propose the solution.	Did not provide evidence

In parallel and through the availability of information on the institutional platform, a comparison was generated between the interest group and the total population, regarding the level of achievement of the competencies (**Figure 4**).



Fig 4. Example of a comparison of achievement levels, interest group – total population

3. Results and Discussion

Educational models require a component of systematic analysis on variables that intervene in the process to contextualize the moment and conditions in which the student finds himself; giving way to the design of strategies, methodologies and guidelines that favor the development of competencies; expressed with continuous adaptation.

Collegial collaboration, Academia, Mentor, and Institutional Effectiveness were essential to guide the work in a clear and strengthened context within the educational process that required the mastery of knowledge and development of competencies.

Through the Mentimeter platform managed by the collegiate group, the application of perception and training monitoring surveys was made possible at the end of the period, they recognized in collaborative work the following skills: analysis-synthesis, decision-making, communication, and time management (**Figure 5).**

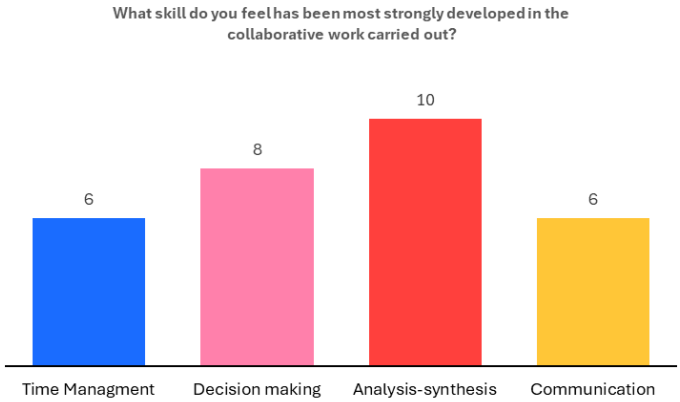


Fig. 5. Example of perception and trainned skills in collaborative work, interest group

- To carry out collaboration: co-responsibility, active listening, tolerance.
- For professional development: problem solving, knowledge of processes, evaluation of properties
- Skills learned from someone on the team that helped improve the learning process: understanding, optimism, resilience and not giving up, tolerance, problem solving, analysis and description, analytical thinking, commitment, effort, perseverance, methodology, dedication, preparation time.
- When facing the resolution of a real problem: Knowledge of methodologies for problem solving, life experience, learning in a real context, development of skills.

Results obtained from the institutional survey confirmed that the strategy is a favorable condition for achieving objectives:

Student A: … *it makes me more perseverant, especially learning to study, to know the origin of things and indirectly forcing myself to grow as a person*.

Student B: … *feeling limited in concepts and computing generated a lot of frustration, but when I began to analyze the problems and look for ways to justify them, I accepted the challenge to continue.*

The identification of precedents and the analysis of the competencies to be developed in relation to their level of achievement and impact on the competencies defined in a graduate profile, was essential to contextualize the moment and the conditions that the student presented during the process of developing the competencies.

The incorporation of differentiating elements of auxiliary techniques such as active and collaborative learning, to a base scenario of challenge resolution, fostered significant learning environments and the development of skills; In summary, the student:

- Faced with the scenario of searching for and analyzing alternative solutions to a proposed challenge in multidisciplinary collaboration teams, being sensitive to the need to know to collaborate, showing more open behavior, flexibility and tolerance in interaction and more active participation.
- Distinguished in practice the different roles of the group members: project integrator, guide for the fulfillment of objectives, results verifier.
- Skills for interaction were strengthened such as listening and effective communication.
- In the solution process, he analyzed and evaluated components, reflected on conditions, made contributions from his area of knowledge, formulated judgments on the proposal and made decisions.
- It was important for the student to work in a collaborative and orderly manner, allowing him to learn from others, learn and apply methodologies, and enhance the development of new skills in the context of co-responsibility and organization.

The integrated measurement by the evaluation of individual evidence confirmed the level of achievement of the competencies. Although, due to the interest of the study, emphasis was placed on the DCs of the UF, the analysis of the skills that are recognized to be developed or strengthened allowed us to conclude about the impact on other graduation competencies: leadership, intellectual curiosity and passion for learning, collaborative work.

Similar results were found in similar studies and contexts. In a case study in the linguistics department at Necmettin Erbakan University in 2018-2019, 28 students in a Project-Based Learning (PBL) declared in the interviews that the activity dealing with a social problem developed in them skills such as active learning, creativity, motivation and critical thinking; these considered lifelong learning skills [23]. In another work at the Portucalense University in Portugal with 18 students of the first year of the Social Education bachelor´s program, the students recognized critical thinking, capacity for initiative, creativity and project management (research skills, decision making and organization) like lifelong learning skills gained when they had a PBL experience using generative artificial intelligence (IA) tools for supporting the project development [24]. Both references evidence the role of CBL at the university level for enhancing lifelong learning skills.

4. Conclusions

The challenging world requires professionals with constant abilities for lifelong learning. These skills can be shaped in undergraduates in higher education through real contextualized experiences with CBL. Tec21 Model, with their elements, contributes to the development of lifelong learning skills found as transversal or disciplinary competencies in its engineering programs. Hence, in this intervention, a formed academic group with multiple roles designed real scenarios where engineering students of the second semester solve problems by applying TCs and DCs in a collaborative environment with CBL and giving them theoretical and practical content.

In the applied surveys, the undergraduates manifested that during the collaborative work, analysis-synthesis was the skill better developed, followed by decision making in second place, and time management and communication as both skills in the third place.

The results show the impact of the experience when incorporating differentiating elements in the teaching-learning process for the development of competencies in response to a need for change. Among some other findings, several important ideas were found and reaffirmed. Personalizing learning maximizes life experiences and reflection, thereby emphasizing the flexibility of the scenarios. A collaborative environment raises the capacities to do, based on continuous learning and social interaction, governed by cognitive flexibility, leading to more open, organized, and systemic behavior.

As final reflexion, it is recommended that the experience be projected in equivalent scenarios, suggesting to continue with the study to systematize the relationship between risk factors and development of competencies throughout the curricular program and obtain more conclusive results.

Acknowledgments

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Mandatory AI Use as a Catalyst for Reflective Practice in Graphic Design Education

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Abstract

The growing presence of Artificial Intelligence (AI) in creative workflows has intensified debates around authorship, originality and learning in higher education. This paper critically reflects on an experience-based pedagogical intervention implemented in a Master's programme in Graphic Design, where the use of AI was made compulsory rather than restricted. Students were asked to design a personal self-promotion kit, combining printed artefacts and a digital portfolio, while maintaining a structured diary documenting their interaction with AI tools throughout the design process. Drawing on a qualitative analysis of students' reflective reports, process diaries and teaching observations, the study examines how enforced transparency and documentation influenced students' learning and design thinking. Rather than framing AI as a productivity tool or a threat to academic integrity, the intervention approached AI as an object of critical literacy within studio-based learning. Findings indicate that AI was predominantly used as a cognitive and organizational support for early-stage exploration, problem framing and technical facilitation, while its limitations, such as visual standardization, literal interpretations and weak material sensitivity, were consistently identified. The requirement to document iterations, failures and decision-making processes fostered reflective practice and slowed down otherwise accelerated workflows, reinforcing students' awareness of authorship and responsibility. Mandatory engagement with AI did not diminish creative agency; instead, it repositioned students as critical mediators who curate, evaluate and transform algorithmic outputs through human judgement. The paper argues that integrating AI within reflective, process-oriented pedagogical frameworks can strengthen critical thinking, ethical awareness and AI literacy in design education, offering a constructive alternative to prohibition-based responses to emerging creative technologies.

Keywords: *Artificial Intelligence; Design education; Reflective practice; Design authorship; AI literacy*

1. Introduction

The rapid normalisation of generative Artificial Intelligence (AI) in creative workflows has produced an unsettled debate within higher design education. On the one hand, design professionals increasingly describe AI tools as instruments of ideation, prototyping and acceleration; on the other, design educators face the difficult question of how to introduce these tools into curricula without either prohibiting them – and pushing their use underground – or naturalising them as a transparent productivity device. Both responses, in different ways, sidestep what is arguably the central pedagogical challenge: cultivating, in design students, a critical literacy in generative AI that treats it as an object of inquiry rather than as a tool of mere convenience.

The literature has begun to articulate this challenge but has only partially answered it. Recent scoping work [9] indicates that, while research on generative AI in design education has grown more than sixfold since the public release of ChatGPT in late 2022, the field remains methodologically nascent and theoretically thin: most studies do not specify measurable outcomes, employ no theoretical framework, and concentrate on a narrow geographic range. The same review identifies graphic design as a particularly under-researched sub-discipline. Within this emerging literature, Fleischmann's recent work [10, 12] proposes a structured curricular response to the integration of generative AI in design education and documents converging international practices – including the requirement that students submit "AI usage statements" alongside their work. Across these contributions, the curricular proposal is broadly consistent: AI literacy should be foregrounded, prompt engagement should be made visible through reflective documentation, and the designer's reconfigured role – as curator, mediator, decision-maker – should become an explicit object of teaching. What this literature does not yet provide is sustained empirical analysis of what such a structured curricular response produces when implemented and rigorously analysed.

This paper presents one such analysis. The empirical site is a Master's-level elective unit in Graphic Design, in which the use of generative AI was made compulsory rather than optional, and reflective documentation in the form of a weekly experimentation diary was made obligatory. Nine students developed a personal self-promotion kit articulating a printed component and a functional website, with AI integrated as an explicit support across all four phases of the design process. The corpus of technical-critical reports and process diaries produced by these students is here analysed through reflexive thematic analysis [4]. The aim is not to determine whether students benefited from AI, nor to measure the effect of AI on creativity, but to surface the patterns through which students articulated and made sense of mandatory engagement with AI within a structured pedagogical context.
The paper makes two contributions. First, it offers an empirical test of the structured curricular response that the literature has so far formulated chiefly at the level of proposal, documenting a set of findings that complicate the prevailing vocabulary of efficiency and threat. Second, it positions a Portuguese case within a sub-disciplinary and geographic gap – graphic design, Southern European higher education – that the most recent scoping review of the field [9] explicitly identifies as under-investigated.
The remainder of the paper is organised as follows. Section 2 situates the work within the pedagogical traditions of design and the emerging literature on generative AI in higher education. Section 3 describes the pedagogical context and the assignment design. Section 4 articulates the methodological procedure and its ethical commitments. Section 5 presents the four themes that organise the findings. Section 6 discusses their implications, and Section 7 concludes by noting limitations and proposing directions for further inquiry.

2. Theoretical Framework

2.1 Reflective Practice and Process-Oriented Learning in Design Education

Design education has long understood itself as a discipline of practice rather than of declarative knowledge. The studio, identified by Shulman as one of the professions' signature pedagogies [15], is where students develop technical skill alongside professional judgement and the capacity to act under uncertainty. At the heart of this pedagogical model lies Schön's account of reflective practice [1] and its dual notions of reflection-in-action and reflection-on-action: the designer learns by acting, observing the consequences of action, and articulating the knowledge that emerges. Kolb's experiential learning cycle [2] provides a complementary structure, and Cross [3] adds that designers' problem-framing is constitutive rather than derivative – designers do not solve problems given in advance but construct the problem in the act of proposing solutions. Together, these frameworks justify the place of the journal, the diary or the process portfolio in design pedagogy: reflection becomes consequential only when it is rendered visible and traceable.

2.2 Generative AI in Higher Design Education: An Emerging and Uneven Field

The emergence of generative AI in higher education has produced an expanding but methodologically uneven literature. A recent scoping review by Musiienko [9], drawing on 156 studies indexed in the Web of Science Core Collection between 2017 and 2026, documents a 6.4-fold increase in publication volume following the public release of ChatGPT in late 2022 while concluding that the field "remains theoretically underdeveloped and methodologically nascent". Among design sub-disciplines, graphic design is dramatically underrepresented, accounting for only 1.9% of the corpus, despite the centrality of image-generation tools in current AI discourse, and is explicitly identified as an under-researched discipline requiring focused investigation [9].
Within this emerging field, the work of Fleischmann offers the most sustained programme of inquiry into generative AI in design education. Two studies are particularly relevant: a survey of 74 design students at an Australian university [10] and qualitative interviews with nine design educators across El Salvador, Indonesia and Denmark [12]. The latter identifies three transversal themes: AI as a "thinking partner", the persistence of manual-first pedagogy as a cognitive anchor, and the rising importance of "prompt literacy" as a new professional competency. Across both studies, Fleischmann consistently argues that AI should be introduced into design curricula in a structured rather than *ad hoc* manner, and that reflective documentation of AI use should function as a metacognitive strategy rather than as a procedural requirement. However, neither study analyses the student-produced material that such a structured curricular response generates. The present paper is positioned within this gap.
The broader literature converges on a vocabulary that is internally consistent across institutional contexts. The designer is repeatedly described as moving from "maker" to "curator" or "director" of AI-

generated material [9, 12]. Bartlett and Camba [11] document, in product design education, concerns about originality and ethics that closely parallel those expressed in the graphic design context. Hwang and Wu [13], working with image-generation tools in a graphic design course, propose the figure of the "content creator" as a way of describing the designer's reconfigured role. Lupetti et al. [14] add a further dimension, drawing attention to the environmental costs of generative AI in design education and arguing for a critical literacy that includes ecological reasoning. This last contribution is especially relevant because environmental concerns emerged spontaneously in the present study's corpus, suggesting that the issue is not idiosyncratic but part of a wider critical horizon.

Two critical perspectives complete this framing. Selwyn [6] argues against the technosolutionist narratives that frame AI primarily as an efficiency device, urging a vocabulary of literacy, context and power. Bearman, Ryan and Ajjawi [7] map the discourses of AI in higher education and identify three dominant framings – efficiency, threat to academic integrity, and inevitable opportunity – none of which adequately captures the pedagogical question of how AI becomes an object of critical inquiry rather than a tool of production. Holmes, Bialik and Fadel [8] further frame AI literacy as a competency to be cultivated rather than a skill to be acquired. The present study is positioned within this critical orientation: it does not ask whether AI should be used in design education, nor whether students enjoy using it, but what happens, pedagogically, when its use is made compulsory and reflexively documented within a structured studio assignment.

3. Pedagogical Context and Assignment Design

The assignment that constitutes the empirical site of this study was designed and delivered within the unit *Design e Tecnologias*, an elective unit offered in the first semester of the first year of the Master's degree in Graphic Design at the School of Applied Arts (ESART) of the Polytechnic Institute of Castelo Branco, Portugal, during the academic year 2025/26. The author was the unit's Invited Assistant Professor at the time and is the sole designer and analyst of the intervention; the analysis presented in this paper was conducted after his transition to a full-time position at the University of Aveiro, Portugal, where it forms part of his current research activity at ID+. The cohort of nine students consisted of recently enrolled Master's students who had self-selected into an elective unit explicitly framed around the intersection of design and emerging technologies, and were therefore at an early formative stage in the negotiation of their professional identity as designers while also having actively chosen a context in which engagement with technological tools was foregrounded.

The assignment, titled *Self-Promotion Kit – Design and AI*, was framed by the working assumption that the contemporary graphic designer must develop critical literacy in generative AI, understood neither as a productivity device nor as a threat to authorship, but as an object of design inquiry in its own right. Students were required to develop a personal self-promotion kit articulating two complementary components: a printed component, conceived at full scale and to professional production standards, and a functional website prolonging the same identity into the digital domain. The printed component could take the form of any combination of graphic supports – catalogue, brochure, poster, manifesto, or other formats – provided that it operated as a coherent expression of the student's emerging identity as a designer. The choice to centre the assignment on a self-promotion kit, rather than a fictional client brief, was deliberate: artefact and subject coincide, since students design the visual identity through which they will represent themselves as designers entering the profession (see Section 6.2). AI was to be used as an explicit support throughout the four phases of the design process – Discover, Define, Develop and Deliver – and all interactions with AI tools were to be documented in a weekly process diary.

The pedagogical structure unfolded across eight sessions over a thirteen-week period, organised around four phases: an introductory session framing the question of authorship under AI; visual identity development and iterative production of printed prototypes (three sessions); development of two successive functional versions of the website (two sessions); refinement of digital interactivity (one session); and final in-class presentation (one session). Submission was made through the institutional learning management system on 12 January 2026.

Three features of the assignment are decisive for the analysis that follows. The first is the obligatory and transparent character of AI use: students were not permitted to opt out, nor were they permitted to use AI without documentation. This deliberately inverts the dominant pattern in higher education, where AI is either prohibited or tacitly tolerated, with the consequence that its use becomes either covert or unreflexive. The second feature is the compulsory diary, conceived not as a record of activity but as a metacognitive device intended to slow the production cycle, expose decision-making and render the iterative structure of the work traceable. The third feature is the dual material constraint: the requirement to produce both a printed artefact and a functional digital interface forced students to confront the

differential behaviour of generative AI across material domains, an opposition that emerged as analytically productive in the subsequent thematic analysis. The intervention therefore operationalises, in a specific national and disciplinary context, the structured curricular response that Fleischmann [10] argued for at the level of proposal, and articulates with the practices of "AI usage statements" and prompt justification that Fleischmann [12] documented internationally.

4. Methodology

This study employs a qualitative interpretive approach to examine the material produced by students during and after the assignment. The aim is not to measure the impact of generative AI on creativity through quantifiable indicators, but to surface the patterns through which students articulated, problematised and made sense of their interactions with AI within a structured pedagogical context. Given this aim, *reflexive thematic analysis* in the sense recently consolidated by Braun and Clarke [4, 5] was selected as the analytical method. The study is framed within an interpretivist orientation with a critical-constructionist inclination: themes are understood as analytical constructions produced by the researcher in iterative engagement with the corpus rather than as entities awaiting discovery in the data; meaning is taken to be situated and shaped by the researcher's interpretive position; and heterogeneity within the corpus is treated as a property to be represented rather than as noise to be filtered.

4.1 Corpus

The corpus comprises the technical-critical reports and the experimentation diaries produced by the nine students enrolled in *Design e Tecnologias* during the academic year 2025/26. Reports range in length from approximately 1,500 to 9,000 words; diaries vary more widely, from short captioned visual logs to extended weekly written entries. The combined textual corpus, after extraction and cleaning, totals approximately 31,700 words. Visual material accompanying the submissions – printed pieces, screenshots, mockups, prompt outputs – was consulted as context but was not subject to systematic analysis, since the focus of the study is on the verbal articulation of the design process.

4.2 Ethical Procedure

The reports and diaries were originally produced as coursework for academic assessment, not as research data. To use this material for research purposes, individual informed consent was obtained from each of the nine students through retrospective contact by email. The consent request explained the scope and purpose of the publication, clarified that all citations would be anonymised through alphanumeric codes (S1 to S9), specified that no visual material would be reproduced, and offered the option to refuse without academic consequence. All nine students consented to the use of anonymised excerpts. Excerpts were reviewed to remove or generalise indirect identifiers that might enable re-identification.

4.3 Analytical Procedure

The analysis followed Braun and Clarke's [4] six-phase reflexive procedure: familiarisation, inductive coding in a structured matrix preserving provenance, iterative aggregation into candidate themes, review against the corpus as a whole, consolidation, and writing-up. Internal variation within themes, including formulations that complicate or partially counter the dominant pattern, was retained rather than excluded.

4.4 Researcher Position and Limitations

The author is, simultaneously, designer, lecturer and analyst of the intervention. This concentration of roles has both an interpretive advantage – depth of contextual knowledge – and an analytical risk: confirmation bias. To mitigate this risk, theme names were not fixed in advance but constructed through iterative engagement with the material, and points at which the corpus diverges from the pedagogical intention were sought out and explicitly retained. Three further limitations should be acknowledged: sample size (nine students; the findings are not offered as generalisable); single-coder design; and the partially mediated nature of the textual corpus, since several students declared the use of AI tools in editing their reflective writing – a complication treated as itself part of the phenomenon under study.

5. Findings

The thematic analysis constructed four themes that organise the patterns observed across the corpus. The themes are presented in the order in which they structured the design process for the participating students, from initial encounter with AI tools to retrospective evaluation of the experience. Each theme names a dominant pattern; internal variations are retained within the analytical narrative rather than smoothed over.

5.1 AI as Cognitive Scaffold Rather Than Authorial Agent

Across the corpus, students consistently describe AI as a tool that supported the organisation of thought, the structuring of unclear ideas, and the accelerated exploration of conceptual and visual possibilities. AI is recurrently positioned as an aid to ideation, not as a producer of authorial decisions. The reflective vocabulary the students adopt – "organising the thinking", "structuring", "clarifying", "accelerating exploration" – converges on a model of AI as cognitive scaffold rather than creative agent. S8 articulates this most directly, noting that the tool *"acts as an instrument for organising thought, not for generating concepts"*, while S4 describes how *"AI was integrated as a support tool, not as an autonomous creative agent"*. The convergence of formulation across distinct voices is itself part of the finding. This framing aligns with the wider literature on generative AI as a "thinking partner" [12], but it also reflects the deliberate framing of the assignment, which positioned AI explicitly as a support across the Discover, Define, Develop and Deliver phases. Depth of internalisation varied across the corpus: while several students articulate the framing with conceptual sophistication, others adopt the same vocabulary in a more functional register.

5.2 Friction, Slowing and the Productive Role of Documentation

Contrary to the dominant narrative of AI as a productivity accelerator, several participants reported that mandatory AI use slowed their work, generated frustration, and required iteration cycles that exceeded those of unaided practice. Under the conditions of obligatory documentation imposed by the assignment, this difficulty became available for reflection: the weekly diary forced students to translate the experience of misalignment between intention and output into language, and in doing so to make explicit the criteria, preferences and intentions that would otherwise have remained tacit. The dual finding – that mandatory engagement produces friction, and that obligatory documentation transforms friction into learning material – recurs across the corpus and stands as one of the central patterns of the analysis.
S4 articulates the experience of slowing directly: *"I often spent more time on AI than producing from scratch"*. S6 describes how *"the difficulty hindered the creative process; it took time to understand how to use it"*. The most quantitatively striking instance is S8, who reports that *"about 29 versions of the website were generated; small prompt changes produced significant layout shifts"* before concluding the work through a further iteration cycle of comparable magnitude. The pattern is consistent: mandatory AI use, far from removing struggle from the design process, introduced new forms of struggle – versioning loops, prompt reformulation, repeated rejection of generated material.
This pattern does not, however, operate uniformly. At least one student articulates a different relation to difficulty: S7 narrates initial trouble with AI tools but resolves it through a strategy of *"maximum specificity in prompting"* that effectively eliminates friction rather than transforming it into reflective material. This case is instructive precisely because it shows that the transition from difficulty to reflection is not automatic: a student may respond to friction by optimising it away rather than by documenting and interrogating it.

5.3 The Asymmetry Between Print and Digital

The dual material constraint of the assignment – printed component plus functional website – produced a recurrent and analytically productive asymmetry in the corpus. Students consistently report that AI was less effective in supporting decisions about the printed component, where considerations of scale, sequence, paper, binding and bodily interaction with the artefact required forms of judgement that the AI did not adequately scaffold. S4 puts this directly: *"in the printed portfolio AI tended towards literal interpretations"*. In contrast, AI was reported as significantly more useful in the digital component, where it lowered the technical threshold of website production, generated functional code or layouts, and operated within a domain whose conventions are more amenable to algorithmic manipulation. S4 again: *"in the digital portfolio AI proved more effective as it facilitates more technical processes"*.

The asymmetry surfaces a distinction that prevailing accounts of AI in design education have rarely articulated: AI's pedagogical effects are not uniform across material domains, and the materiality of the artefact mediates the cognitive contribution of the tool. For most students, the asymmetry is articulated pragmatically: AI is *more useful for the technical aspects of the website*. For S7, however, the same asymmetry is articulated through an ethical-environmental register: she used AI principally in the digital domain because doing so aligned with her own concern for energy efficiency in the design process. This second formulation extends the discussion of tacit knowledge in design practice [10] by suggesting that print and digital not only make different demands on tacit understanding but invite different normative framings of when and why AI engagement is justified.

5.4 Reconfiguration, Not Dissolution, of Authorship

Across the corpus, students articulate a consistent reframing of their role as designers, not as a loss of authorship in the face of automation, but as a redistribution of authorial activity. The students describe themselves as curators, editors, decision-makers, mediators between human intention and algorithmic output. S4 puts the reframing most concisely: *"the designer's role will evolve from executor to curator, editor and strategist"*. S1 echoes this in describing *"a transition from the role of craftsman to that of strategist and visual curator"*. This vocabulary is not imposed by the assignment; the brief uses the term "mediator", but the language of curation, editing and selection emerges in the reflective writing in formulations that are recognisably the students' own. The convergence of vocabulary across distinct individual trajectories, and across the international literature [9, 12, 13], suggests that the figure of the designer-as-curator is not a rhetorical commonplace but a substantive reorganisation of design practice that is being negotiated, in real time, by the practitioners themselves.

The reframing is not, however, articulated in a single register. S7 formulates the same shift in markedly more anxious terms, suggesting that *"the junior designer's future lies not in execution speed but in management capacity"* – a formulation that positions curatorship as a strategic response to perceived professional threat rather than as a serene reappropriation of authorial role.

A further dimension surfaces in two of the reports: a small but consistent articulation of environmental and ethical concerns about the use of AI, including its energy cost. S7 frames this most directly: *"the ethics of this project rests on ecological responsibility"*, complemented by her observation that *"the use of AI was guided by energy efficiency"*. S8 articulates a related concern: *"ethical reflection came to include awareness of the invisible costs of automated generation technologies"*. This articulation, which echoes recent critical work on the environmental impact of generative AI in design education [14], emerges as part of the same reconfiguration of authorship: to be a designer who works with AI is, for these students, also to be a designer who must take responsibility for the choice to do so. Supported by a minority of the corpus rather than by the majority, the articulation is an emerging minority position rather than a generalised pattern; its analytical significance lies less in its frequency than in its independent emergence, in two distinct voices, in formulations not solicited by the assignment.

6. Discussion

The four themes presented in Section 5 articulate, in the voices of the participating students, a set of patterns that the wider literature has identified at the level of proposal but rarely surfaced in the textured form that a structured pedagogical intervention permits. This section reads those themes against the literature, identifies points of convergence and tension, and discusses the implications of the present case for the wider field.

6.1 Confirmation, Extension and Tension with the Literature

The first theme – AI as cognitive scaffold rather than authorial agent – confirms a finding that has emerged repeatedly across recent studies, including Fleischmann's account of "AI as a thinking partner" [12] and the broader literature on prompt engagement as a metacognitive practice. The vocabulary the students adopt ("organising thought", "structuring", "clarifying") closely tracks the language documented in Australian, Danish, Indonesian and Salvadoran contexts [10, 12]. The convergence is striking precisely because the participating students did not have access to that literature; the formulation is one they reach independently, in negotiation with the assignment and with the tools themselves.

The second theme departs more clearly from the dominant narrative in the literature. Industrial accounts of generative AI consistently describe acceleration, speed and efficiency as its primary affordances [10]; even critical accounts that warn against uncritical adoption [12] do so by reference to AI's excess of

fluency rather than to its difficulty. The students in this corpus describe a more uncomfortable experience: AI, far from accelerating their work, often slowed it; far from removing struggle from the design process, it introduced new forms of struggle – versioning loops, prompt reformulation, repeated rejection of generated material. The pedagogical lesson is not that AI is slower than expected, but that mandatory engagement, when reflexively documented, transforms friction from an obstacle to a learning surface – though, as the findings have shown, not for all students and not always.

The third theme – the asymmetry between print and digital – articulates a finding that is largely absent from the existing literature, which has tended to treat AI's effects on design as if they were uniform across material domains. The students consistently report that AI was less effective in supporting decisions about the printed component, where considerations of scale, sequence, material and physical interaction with the artefact resisted the algorithmic vocabulary of the tools, and significantly more useful in the digital component, where AI lowered the technical threshold of website production. The asymmetry is analytically productive because it surfaces the role of materiality in mediating the cognitive contribution of AI: print and digital make different demands on the tacit understanding designers bring to AI engagement, and AI engages differently with each in consequence.

The fourth theme – reconfiguration, not dissolution, of authorship – converges with what the broader literature has begun to call the shift from "maker" to "curator" [9] or from "designer" to "director" [12]. The vocabulary of curation, mediation and decision-making is articulated by the participating students with notable consistency and in formulations that are recognisably their own rather than imposed by the assignment brief. The convergence is not uniform in register, however: while several students frame the shift as an expansion of authorial agency, at least one articulates the same reconfiguration in markedly more anxious terms, positioning curatorship as a defensive adaptation to perceived professional pressure. A subsidiary strand of this theme – the articulation of environmental and ethical concerns about AI use – deserves particular emphasis. Two students independently raise ecological responsibility as part of their design reasoning, in formulations not prompted by the assignment and aligned with recent critical work on the environmental costs of generative AI in design education [14]. The articulation is supported by a minority of the corpus rather than by the majority, and its analytical significance lies less in its frequency than in its independent emergence in distinct voices. That this concern emerges at all, framed as part of the designer's professional responsibility rather than as an external imposition, suggests that ethical literacy is being internalised as an integral dimension of authorship rather than as a separate compliance requirement – at least for some students.

6.2 The Artefact and the Subject

A pedagogical decision that warrants explicit discussion is the choice to centre the assignment on a self-promotion kit rather than on a fictional client brief. In conventional studio assignments, the artefact and the subject are kept separate: the student designs for an external party, and the rejection of mediocre output carries no personal cost. In the present case, the artefact and the subject coincide: the kit represents the student as a designer entering the profession. We hypothesise that this coincidence is one of the conditions that produced the patterns observed, particularly the systematic rejection of AI-generated material as "not me" reported across multiple cases. When the cost of accepting standardised output is the standardisation of one's own professional self-presentation, the threshold for acceptance rises. This is a hypothesis the present corpus cannot definitively test, but it is consistent with the data and worth marking as a conjecture for further inquiry. It also suggests a practical curricular implication: assignments in which AI use is mandatory may benefit from a high degree of personal investment in the artefact, as a pedagogical multiplier of reflective engagement.

6.3 Implications for the Field

Three implications follow for the wider field. First, the structured curricular response that the literature has been calling for [10] is implementable, produces analytically rich material, and can be defended ethically and methodologically when the appropriate procedural commitments are in place. Second, the dominant rhetoric of AI as a productivity device deserves complication: when AI use is mandatory and reflexively documented, friction and slowed engagement emerge as primary pedagogical resources. The three discourses mapped by Bearman, Ryan and Ajjawi [7] – efficiency, threat to academic integrity, inevitable opportunity – do not adequately capture this pedagogical possibility, and a fourth orientation, organised around critical literacy and structured reflection, deserves explicit articulation alongside them. Third, the development of AI literacy in design education appears to entail not the rejection of AI nor its

naturalisation, but its repositioning as an object of design inquiry – something the designer thinks *with* and *about*, rather than something the designer simply uses.

7. Conclusion

This paper has reported on a pedagogical intervention in which generative AI use was made compulsory within a Master's-level graphic design unit, and student engagement was rendered traceable through obligatory weekly diaries. The reflexive thematic analysis of the resulting corpus constructed four patterns: AI as cognitive scaffold rather than authorial agent; friction and slowed engagement as a counter-narrative to dominant accounts of AI as efficiency device; the asymmetry between AI's effects on print and digital components; and the reconfiguration, rather than dissolution, of authorial agency, including the articulation of environmental and ethical concerns. These patterns are dominant but not uniform: the corpus also includes more utilitarian engagements, anxious framings of the designer's reconfigured role, and at least one case in which friction was optimised away rather than transformed into reflection.

Two contributions follow. The first is empirical: the study offers a qualitative analysis of student-produced material from a structured intervention combining mandatory AI use with obligatory reflective documentation, complicating the prevailing vocabulary of efficiency and threat by documenting difficulty, slowed engagement and material asymmetry as outcomes. The second is positional: the study contributes a Portuguese case to a sub-disciplinary and geographic landscape mapped as significantly under-researched [9].

The limitations of the study are explicit. The sample is small and the corpus partially mediated; the analyst is also the educator, and the findings are presented as theoretically suggestive rather than as statistically generalisable. The pedagogical context is specific: an elective unit in a Portuguese polytechnic Master's programme, with a particular cohort and a particular brief. No claim is offered that the same patterns would emerge under different framings.

Three directions for further inquiry follow naturally from this work: replication across institutional contexts, attentive to the variables that the present case holds fixed; longitudinal study of how the dispositions documented here evolve as students move into professional practice; and cross-disciplinary comparison across design sub-disciplines that may engage AI under materially different conditions. Whatever the trajectory of generative AI itself, design education's task is unlikely to consist in choosing between adoption and prohibition. It is more likely to consist in cultivating, in students, the critical literacy through which AI can be read as one more material of design – a material with particular affordances, particular costs, and a particular relationship to the question of who, in the act of designing, is doing the deciding.

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Cultivating AI-Ready Graduates: Curriculum Coherence and Tiered Competency Development in Business Education

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Abstract

As artificial intelligence reshapes professional practice, business education faces a curricular design challenge: how to embed AI capability development without reducing it to tool training or isolating it within a single course. This paper presents a theoretically grounded, qualitative curriculum design study that advances a Tiered Curriculum Integration Approach to embed eight workforce-relevant AI competencies across a Bachelor of Business Administration (BBA) program in a US-based university. The study positions AI integration not as technological adoption, but as a problem of curriculum coherence, cognitive development, and the urgent need to build AI competency in business education in response to the evolving business needs. Drawing on curriculum theory, adult learning theory, and constructivist pedagogy, the framework reconceptualizes AI competency development as a vertically scaffolded process across the undergraduate experience. The research documents a multi-phase qualitative methodology used to identify and define eight core competencies aligned to business workforce expectations: AI literacy and fundamentals; data privacy literacy; advanced prompt engineering; AI tools and automation; programming AI agents; critical thinking and problem-solving; strategic AI use; and AI communication skills. Competencies were derived through environmental scanning of employer discourse, review of AI literacy frameworks, and iterative faculty working sessions using thematic analysis. The conceptual contribution of the study lies in the development of a four-tier integration model, namely Foundations, Creation and Control, Building and Evaluation, and Leadership and Impact, explicitly mapped to Bloom's Taxonomy and the principles of constructive alignment. Rather than adding AI content horizontally, the model vertically scaffolds cognitive complexity from foundational comprehension to strategic evaluation and ethical leadership. This structure reflects constructivist assumptions that learners build knowledge through progressively complex engagement and aligns with adult-learning principles that emphasize relevance, autonomy, and authentic problem contexts. In the next phase of the project, curriculum mapping workshops engaged faculty in aligning course learning outcomes, assessment practices, and AI competencies within existing disciplinary structures. This process operationalized alignment between institutional goals, professional standards, and course-level pedagogy without requiring wholesale curriculum redesign. As a result, this study contributes a replicable model for university programs seeking to systematically and ethically integrate AI into curricular design.

Keywords: *curriculum design, AI curriculum integration, AI competencies, business education*

1. Introduction

Artificial intelligence (AI) is rapidly transforming business functions, decision-making processes, and workforce expectations. From marketing analytics to financial forecasting and operations management, AI-enabled tools are becoming embedded across industries [5]. As a result, business graduates are increasingly expected to demonstrate not only familiarity with AI technologies but also the ability to critically evaluate, ethically apply, and strategically leverage AI in organizational contexts. Despite this shift, responses within business education have often been fragmented. Many institutions have introduced standalone AI or analytics courses, while others incorporate isolated assignments using generative AI tools. These approaches, however, frequently emphasize tool usage over deeper cognitive and ethical competencies and lack program-level coherence [16]. As a result, students may graduate with uneven exposure to AI concepts, limited critical evaluation skills, and insufficient preparation for real-world applications.

This paper argues that AI integration is fundamentally a curriculum design problem, rather than merely a technological or instructional issue. Specifically, the challenge lies in systematically embedding AI competencies across a program in ways that align with cognitive development, disciplinary learning, and professional expectations. We address it through a Tiered Curriculum Integration Approach that embeds

AI competencies across a Bachelor of Business Administration (BBA) program. The approach is grounded in curriculum theory, constructivist learning principles, and adult learning theory, and it emphasizes vertical scaffolding of competencies across courses rather than horizontal addition of content. The purpose of this paper is to document the qualitative design process used to (1) identify workforce-relevant AI competencies, (2) develop a tiered curriculum integration model aligned with Bloom's Taxonomy, and (3) map these competencies across a BBA curriculum. The study contributes a theoretically informed and practically applicable model for business schools seeking coherent and ethical AI integration.

2. Theoretical Framework

2.1. Curriculum Design and Constructive Alignment

Curriculum design has long been understood as an intentional and systematic process of aligning learning outcomes, instructional activities, and assessment practices [10]. Building on this foundation, [2] introduced the concept of constructive alignment, which emphasizes the alignment between what students are expected to learn and how they are taught and assessed. In the context of AI integration, constructive alignment highlights the limitations of ad hoc approaches. Simply introducing AI tools into assignments does not ensure that students develop meaningful competencies. Instead, AI-related learning outcomes must be explicitly defined, supported through appropriate learning activities, and assessed through authentic tasks. Without such alignment, AI integration risks becoming superficial and disconnected from broader educational goals.

2.2 Constructivist Learning Theory

Constructivist theory posits that learners actively construct knowledge through interaction with content, context, and experience [4], [14] Learning is not a passive process of information acquisition but an active process of meaning-making, shaped by prior knowledge and social context. Applying constructivism to AI education suggests that students must engage with AI tools in meaningful, context-rich ways. Rather than simply learning about AI concepts, students should experiment with AI outputs, evaluate their accuracy, and refine their use based on feedback. This iterative engagement enables deeper understanding and supports the development of higher-order thinking skills.

2.3 Adult Learning Theory

Adult learning theory, or andragogy, emphasizes that learners are self-directed, goal-oriented, and motivated by relevance to real-world contexts [7]. In business education, this implies that learning experiences should be authentic, problem-centered, and directly applicable to professional practice. In the context of business education, this implies that AI competencies must be situated within authentic disciplinary contexts rather than taught as abstract or purely technical skills. Students are more likely to internalize AI-related knowledge when it is directly connected to managerial decision-making, ethical dilemmas, and organizational challenges. Consequently, AI integration must occur within existing business courses, where students can apply AI tools to meaningful problems rather than treating AI as a separate domain.

2.4 Bloom's Taxonomy and Cognitive Development

Bloom's Taxonomy provides a framework for understanding cognitive progression, ranging from lower-order skills, such as remembering and understanding, to higher-order skills, such as evaluating and creating [1]. Effective curriculum design requires scaffolding learning experiences to support this progression. In business education, this progression is particularly important. Students must first understand fundamental concepts before applying tools, analyzing outputs, and ultimately using AI strategically and ethically. Aligning AI competencies with Bloom's Taxonomy ensures that learning is developmentally appropriate and cognitively rigorous.

2.5 Instructional Design Principles for Competency Development

To translate constructive alignment from a curriculum-planning principle into learning experiences, the study is additionally informed by instructional design frameworks that specify how skill development is

sequenced and reinforced. Merrill's Five Principles of Instruction emphasize problem-centered learning, activation of prior knowledge, demonstration, application, and integration [9], providing rationale for designing authentic, workplace-relevant AI tasks that recur across tiers with increasing complexity. As learners engage in each tier, Gagné's Nine Events of Instruction offer micro-level structures, ensuring that learners receive clear expectations, guided practice opportunities, actionable feedback, and opportunities to transfer learning into workplace application [6]. Together, these frameworks support mastery progression by combining authentic performance with systematic scaffolding, supporting this study's goals of developing AI capability through sustained, program-level integration.

2.6 Synthesis

Together, these theoretical perspectives underscore the need for a structured, aligned, and progressive approach to AI integration. A tiered curriculum model enables institutions to move beyond fragmented interventions toward a coherent framework that supports both cognitive development and professional readiness. Importantly, such an approach reframes AI not as a discrete content area but as a capability that must be developed through sustained, aligned engagement across the curriculum. Within this framing, AI competencies are not endpoints but developmental outcomes that evolve as students' progress through increasingly sophisticated levels of learning and practice. Ultimately, these theoretical perspectives support the central premise of this study: that meaningful AI integration in business education requires a tiered, programmatic approach that ensures coherence, cognitive progression, and alignment with professional practice.

3. Methodology

This study employs a qualitative, design-based research approach focused on curriculum development. Design-based research is particularly appropriate for addressing complex educational challenges, as it involves iterative design, implementation, and refinement of educational interventions in real-world contexts [15]. Unlike purely evaluative or experimental methods, this approach prioritizes the development of theoretically grounded and practically applicable solutions, making it well-suited to emerging areas such as AI integration in higher education. Our focus is on understanding how AI competencies can be identified, structured, and embedded within an existing program in a way that is both pedagogically sound and institutionally feasible.

3.1 Data Sources

The development of the AI competencies was informed by three primary qualitative data sources: (1) environmental scanning of workforce expectations, (2) review of AI literacy frameworks, and (3) faculty working sessions. These sources were intentionally selected to triangulate perspectives from industry, scholarship, and disciplinary practice, ensuring that the resulting competencies were both theoretically grounded and practically relevant.

The first data source involved an environmental scan of industry reports, professional publications, and job postings to identify emerging expectations for AI-related skills in business roles. This process included reviewing publicly available job descriptions across business functions such as marketing, finance, and human resource management, with particular attention to language referencing artificial intelligence, automation, data-driven decision-making, and digital tools. In addition, reports from consulting firms were examined to capture broader trends in workforce transformation driven by AI adoption. Through iterative review, patterns emerged emphasizing not only technical familiarity with AI tools, but also the ability to critically evaluate AI outputs, apply AI in decision-making processes, and communicate insights effectively. These findings informed the initial set of competency categories and ensured alignment with real-world business expectations.

The second data source consisted of a review of existing AI literacy and competency frameworks, including those proposed by Long and Magerko [8], UNESCO [12], and the U.S. Department of Labor's Artificial Intelligence Literacy Framework [13]. These frameworks provide structured definitions of AI-related knowledge, skills, and attitudes, often emphasizing interdisciplinary understanding and ethical awareness. The review focused on identifying common constructs across frameworks, such as foundational AI knowledge, data literacy, ethical reasoning, and human-AI interaction. Particular attention was given to how these frameworks conceptualize AI literacy beyond technical expertise, incorporating critical thinking, societal impact, and responsible use.

The third data source involved a series of working sessions of the AI Pedagogy and Curriculum task force. These sessions served as a critical mechanism for contextualizing and operationalizing AI competencies within the BBA curriculum. The members engaged in collaborative discussions to interpret the preliminary competency categories, assess their relevance to disciplinary learning outcomes, and identify opportunities for integration within existing courses. Activities included reviewing sample assignments, mapping competencies to course objectives, and discussing appropriate levels of cognitive complexity based on course sequencing. These discussions were iterative, with competencies refined over multiple sessions based on faculty feedback and consensus-building.

3.2 Analytical Approach

Data were analyzed using thematic analysis [3]. The analysis was primarily inductive, allowing themes related to AI competencies and workforce expectations to emerge through a repeated review of the collected materials. Initial codes were developed based on recurring themes related to AI skills, competencies, and workplace applications. Initial coding focused on identifying recurring references to AI-related knowledge, skills, behaviors, and professional expectations across the environmental scan, literacy frameworks, and faculty discussions. Similar concepts were grouped into broader competency categories, which were subsequently refined through comparison across data sources.

The analytical process was iterative rather than strictly linear. Preliminary competency categories were discussed and revised during working sessions, during which participants evaluated their relevance, clarity, and applicability within business education contexts. These conversations helped refine the scope of individual competencies and distinguish between foundational and more advanced AI capabilities. For example, competencies related to basic AI literacy and tool usage were differentiated from those emphasizing strategic judgment, evaluation, and leadership.

In addition to identifying competency domains, the analysis also informed the development of the tiered integration structure. Patterns across the data suggested that AI competency development should occur progressively, with students moving from conceptual understanding toward increasingly complex applications and evaluations. These observations supported aligning the framework with Bloom's Taxonomy and informed the differentiation of curriculum-integration levels across the BBA program.

While the study did not aim to develop a formal theory, the analytical approach provided a structured and collaborative process for translating broad workforce and educational trends into an operational curriculum framework. The analysis emphasized practical applicability, curricular coherence, and alignment with the professional expectations of contemporary business education.

4. Development of AI Competencies

The development of the institutional AI competencies represented the transition from conceptual exploration to operational curriculum design. Building on the environmental scan, review of AI literacy frameworks, and collaborative faculty working sessions, the project focused on translating broad workforce and educational trends into a coherent competency structure appropriate for undergraduate business education. Rather than positioning AI as a standalone technical specialization, the framework conceptualized AI capability as an applied professional skill set that could be integrated across the BBA curriculum.

Throughout the development process, particular attention was given to ensuring that competencies reflected both workforce relevance and pedagogical applicability. Early discussions within the task force identified a common limitation in many AI integration efforts: an emphasis on procedural tool use without sufficient focus on evaluation, interpretation, and professional judgment. In response, the framework was intentionally designed to support higher-order engagement with AI technologies by emphasizing critical thinking, strategic application, ethical reasoning, and communication alongside technical interaction.

The framework was also developed to support the scalable integration within existing curricular structures. Rather than requiring wholesale program redesign, competencies were articulated in applied terms that faculty across business disciplines could adapt to existing course outcomes, assignments, and assessment practices. This approach aligned with institutional priorities related to innovation, equity, and collaboration.

Three considerations guided the refinement of the competencies. First, the framework prioritized workforce applicability by emphasizing the ability to apply AI in problem-solving and decision-making contexts relevant to contemporary business practice. Second, ethical reasoning and responsible AI use were embedded throughout the competency structure rather than isolated as a standalone topic,

reinforcing the importance of accountability, bias awareness, and critical evaluation, aligning with emerging guidance such as the U.S Department of Labor's AI skill standards [13]. Third, the competencies were structured developmentally to support progressive learning across the undergraduate experience, enabling students to move from foundational understanding toward more advanced application, evaluation, and strategic use of AI. The intent is to create a scaffolded learning experience, operationalized through Gagné's Nine Events of Instruction [6], which correspond to increasing levels of cognitive complexity, as outlined in Bloom's Taxonomy.

The resulting framework identified eight interconnected AI competencies designed to function as an integrated skill stack across the BBA curriculum (see Figure 1). These competencies were intended to be reinforced across courses and aligned with course-level outcomes, assessment strategies, and increasing levels of cognitive complexity throughout the program.



Fig. 1. AI Skill Stack

5. Tiered Curriculum Integration Model

To operationalize the AI competency framework within the BBA curriculum, a four-tier curriculum integration model was developed to support a structured implementation across courses and program levels. Rather than relying on isolated assignments or standalone AI instruction, the model was designed to facilitate intentional integration that could evolve alongside technological and workforce changes while remaining adaptable to existing curricular structures.

The tiered approach reflects the study's theoretical grounding in constructive alignment, constructivist learning theory, and adult learning theory by emphasizing developmental progression, repeated practice, and authentic application. Instead of organizing learning around specific AI tools, the model centers on transferable competencies and cognitive processes that can be adapted as technologies continue to change. This competency-centered approach was intended to reduce curricular disruption while providing faculty with a flexible structure for integrating AI within disciplinary contexts.

The model consists of four progressively complex levels: Foundations, Creation and Control, Building and Evaluation, and Leadership and Impact (see Figure 2). Each tier represents increasing levels of cognitive engagement, professional application, and learner autonomy. Together, the tiers provide a scaffolded progression that moves students from foundational understanding of AI concepts toward strategic, ethical, and contextually informed use of AI in professional settings.

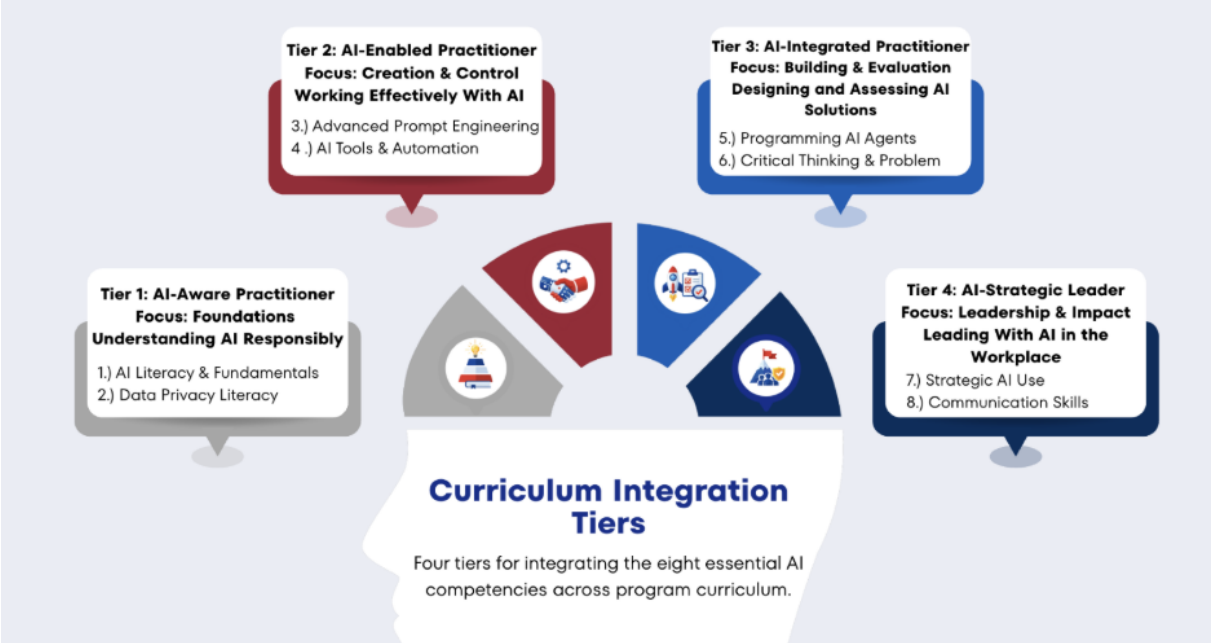


Fig. 2. Curriculum Integration Tiers

The first tier, **Foundations**, focuses on developing basic AI literacy, including understanding core concepts, limitations, risks, and ethical considerations associated with AI technologies. At this level, students are introduced to AI terminology, foundational principles, and responsible use practices. Learning activities emphasize comprehension and awareness, aligning primarily with the lower levels of Bloom's Taxonomy, such as remembering and understanding.

The second tier, **Creation and Control**, emphasizes intentional interaction with AI tools through applied use, prompt development, and reflection on how inputs influence outputs. At this stage, students begin using AI to support learning and problem-solving activities while developing awareness of the strengths and limitations of AI-generated content. Learning experiences focus on application and experimentation, supporting progression toward greater learner agency and technological fluency.

The third tier, **Building and Evaluation**, shifts toward more advanced engagement with AI-supported processes and outputs. Students are expected to critically evaluate AI-generated information, assess accuracy and bias, and apply AI within discipline-specific contexts to support analysis and decision-making. This tier emphasizes higher-order cognitive processes associated with analysis and evaluation, including judgment, refinement, and evidence-based reasoning.

The final tier, **Leadership and Impact**, focuses on strategic and ethical application of AI within organizational and societal contexts. At this level, students are expected to communicate AI-informed insights to diverse audiences, consider broader ethical and professional implications, and demonstrate leadership in responsible AI use. Learning activities emphasize evaluation, synthesis, and creation, aligning with the highest levels of Bloom's Taxonomy.

Collectively, the four tiers provide a vertically scaffolded structure for integrating AI competencies across the curriculum. By distributing competency development across courses and program stages, the model supports gradual skill development, reinforces learning through repeated engagement, and reduces cognitive overload for adult learners, balancing academic, professional, and personal responsibilities. Most importantly, the framework positions AI competency development as an ongoing and integrated component of business education rather than a discrete technical skill acquired in isolation.

6. BBA AI Curriculum Mapping

Following the development of the tiered curriculum integration framework, the next phase of the project focused on operationalizing the model within the BBA curriculum through program-level mapping. Curriculum mapping is widely recognized as a mechanism for strengthening alignment between program outcomes, instructional practices, and student learning progression [11]. In the context of AI integration, the mapping process served as a strategy to translate abstract competency categories into discipline-specific learning experiences distributed across the undergraduate business curriculum.

The mapping process was guided by the principles of constructive alignment [2], scaffolded learning, and competency-based curriculum design. Rather than treating AI as a standalone subject area, the approach positioned AI competency development as an integrated, developmental process embedded within existing business disciplines. This design reflects emerging perspectives in higher education that emphasize AI literacy as a cross-functional professional capability rather than a purely technical specialization [8].

Courses were mapped according to the four-tier integration model based on three primary considerations: (1) the cognitive complexity of course-level learning outcomes, (2) the degree of authentic AI application appropriate within the specific discipline and corresponding workforce setting, and (3) the developmental progression of students across the program. Hence, introductory courses emphasizing foundational business concepts and digital literacy were aligned with Tier 1 (Foundations), while intermediate and advanced courses requiring applied analysis, evaluation, strategic decision-making, and professional communication were aligned with progressively higher tiers.

The mapping process intentionally emphasized authentic assessment and contextual application. Consistent with adult learning theory, students engage with AI within meaningful disciplinary contexts rather than through isolated technical exercises [7]. For example, in Principles of Macroeconomics, students evaluate AI-generated economic forecasts and assess their limitations, while in Business Statistics, students refine prompts and compare AI-assisted analyses with manually generated results. At more advanced levels, students move toward evaluating AI-supported strategic recommendations, designing AI-enabled workflows, and communicating AI-informed insights to organizational stakeholders.

The progression across tiers also reflects increasing levels of cognitive complexity aligned with Bloom's Taxonomy [1]. Early-course integration focuses on comprehension, awareness, and responsible use, while upper-level courses emphasize evaluation, judgment, synthesis, and strategic leadership. This developmental structure supports repeated exposure and reinforcement of competencies across courses, which is consistent with constructivist perspectives emphasizing iterative knowledge construction through progressively complex engagement [4], [14].

Importantly, the curriculum map was designed to support sustainable faculty adoption and curricular flexibility. By centering competencies rather than platform-specific tools, the framework allows faculty to adapt assignments and learning activities as AI technologies continue to evolve. This approach also minimizes the need for extensive course redesign by embedding AI competencies within existing learning outcomes and disciplinary practices. Instead, it presents as a natural enhancement of the existing curriculum.

Figure 3 illustrates the operationalized BBA AI curriculum map, including representative courses, aligned competencies, and examples of authentic assessments and learning activities across each tier. The map demonstrates how AI competency development can be distributed systematically across a business curriculum to support progressive, ethical, and workforce-relevant learning experiences.



Fig. 3. BBA Program AI Integration Map

7. Conclusion

As artificial intelligence continues to reshape business practice, business education must move beyond isolated tool adoption toward coherent and developmentally structured curriculum integration. This study contributes to curriculum theory by extending principles of constructive alignment and scaffolded learning to program-level AI competency development within a BBA curriculum. The Tiered Curriculum Integration Approach provides a practical and scalable framework for embedding AI competencies across program courses while supporting ethical reasoning, cognitive development, and workforce relevance. Importantly, the framework was intentionally designed to enhance and modernize existing curriculum structures rather than require a complete program overhaul. By embedding AI competencies within existing disciplinary courses through learning activities and assessments, the model offers institutions a more sustainable and adaptable pathway for curricular innovation. This approach allows business programs to increase workforce relevance and respond to evolving employer expectations while minimizing disruption to faculty workload, accreditation structures, and established curricular sequencing. Because the BBA pilot has not yet been implemented, the present study is limited to the design and development processes underlying the framework. Future research will examine implementation outcomes, including student learning, faculty experiences, and the longitudinal development of AI competencies across the program.

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Are Functional and Critical Digital Skills Distinct? Evidence from Set Bifactor-ESEM Using the yDSI among Students

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Abstract

This study investigated the structural validity of students' digital skills by comparing eight competing measurement models, including Confirmatory Factor Analysis (CFA), Exploratory Structural Equation Modeling (ESEM), and bifactor-ESEM variants, using data from a sample of 603 university students. All models aimed to assess both critical and functional digital skills, providing a comprehensive evaluation of the multidimensional structure of digital competence. Model performance was evaluated using robust fit indices: χ^2, RMSEA, CFI, TLI, and SRMR. The Set bifactor-ESEM model demonstrated superior fit (χ^2 (368) = 729.47, RMSEA = .040 [90% CI: .036–.045], CFI = .994, TLI = .992, SRMR = .022), outperforming both traditional CFA and Full bifactor-ESEM models. Examination of the latent structure highlighted distinct patterns across the two digital skill domains. Critical skills adhered to a predominantly unidimensional configuration anchored by the general factor, whereas functional skills exhibited a clearly multidimensional structure informed by their specific subdomains. The general factors of the two layers were only weakly correlated (r = .29), despite being statistically significant. Two subcomponents tied to strategic and creative digital skills showed a significant cross-set association. In contrast, the majority of factor correlations obtained from the full ESEM model were statistically non-significant (e.g., CIC–TO: r = .025, p = .894; CIC–INP: r = .067, p = .606), highlighting the empirical separation of critical and functional skills. These findings suggest that digital skills are best conceptualized as a layered construct, comprising interrelated but structurally distinct domains. Implications for assessment design, educational interventions, and theoretical modeling are discussed.

Keywords: *digital competence; yDSI; critical digital literacy; Set bifactor-ESEM; WLSMV; higher education*

1. Introduction

In an increasingly digitalized society, acquiring digital competence is essential for meaningful participation in social, economic, and civic life. Established frameworks such as DigComp [1] and the cross-nationally validated youth Digital Skills Indicator (yDSI) [2] conceptualize digital competence as a multidimensional construct that spans information, communication, content creation, safety, and problem-solving. A core feature of these frameworks is the distinction between functional and critical digital skills. Functional skills involve procedural and task-oriented digital practices, whereas critical skills encompass evaluative, reflective, and harm-mitigating capacities essential for informed digital engagement [3].

The short yDSI scale reflects this structure through two heterogeneous item sets: functional skills are measured through behavioral self-report items, while critical skills rely on knowledge-based items. With this design, some overlap among items is expected within each layer, yet overlap between layers is deliberately restricted to maintain their conceptual separation.

Integrating these components into the core of educational curricula is increasingly regarded as a priority [4]. Still, to shape curricula that genuinely support students, it is important to understand more precisely how functional and critical skills work together.

Given the multidimensionality of digital competence, appropriate methodological models are needed to capture its internal structure accurately.

2. Methodological Overview of Competing Latent Variable Techniques

For hierarchical constructs, bifactor specifications are often recommended to separate general (G) and specific (domain-level) sources of variance. Bifactor-ESEM [5] extends this logic with ESEM's flexibility, and Set bifactor-ESEM further constrains the space of cross-loadings to within-set relations, providing a principled compromise among fit, parsimony, and interpretability. Meta-analytic evidence indicates

that bifactor-ESEM models generally yield superior fit and more defensible parameters for complex educational constructs [6].
Exploratory Factor Analysis (EFA) is a data-driven method for identifying latent dimensions without imposing prior structural constraints. All items freely load on all factors, with oblique rotations used to obtain interpretable patterns. EFA is valuable for probing dimensionality and detecting cross-loadings when theory is limited, but it is not confirmatory and does not provide global fit indices for hypothesis testing. Consequently, it is less suitable when specific item–factor relationships are theoretically expected [7].
Independent Cluster Model CFA (ICM-CFA) specifies that each item loads on a single factor, with all cross-loadings fixed to zero.
This strict structure provides strong confirmatory control and allows the use of global fit indices. The model is highly parsimonious and straightforward to interpret, making it suitable when constructs are clearly separable and cross-loadings are negligible. However, the zero cross-loading assumption is often unrealistic for multidimensional constructs, leading to inflated factor correlations and compromised discriminant validity, as frequently observed in digital competence research [7].
Full ESEM integrates the flexibility of EFA with the hypothesis-testing capabilities of SEM. All non-target cross-loadings are freely estimated, typically under target rotation to approximate the intended structure. This approach generally achieves better fit and more realistic factor correlations than CFA, accommodating construct-relevant multidimensionality without post hoc modifications. Lower parsimony and the presence of numerous cross-loadings can complicate interpretation, particularly when theoretical guidance is weak [6], [7].
In *full Bifactor-CFA*, each item loads on a general factor (G) and one specific factor, while all cross-loadings remain fixed to zero. This structure separates general and domain-specific variance, making it informative for hierarchical constructs. The prohibition of cross-loadings can lead to misfit or biased estimates when multidimensional cross-loadings are plausible [5], [8].
Full Bifactor-ESEM combines bifactor logic with ESEM flexibility, allowing items to load on G and cross-load on multiple specific factors. It offers the most comprehensive representation of hierarchical, multidimensional constructs and often reduces bias in loadings and correlations relative to CFA. This approach is highly parameterized, necessitating large sample sizes and a strong theoretical foundation; it may also present estimation challenges [5], [6].
In *Set CFA (Second-Order or Set-Restricted Confirmatory Factor Analysis*), items are organized into theoretically defined sets (e.g., functional vs. critical), with cross-loadings between sets fixed to zero. Within each set, standard CFA constraints are applied. This structure preserves the a priori conceptual distinction between item types, supporting model parsimony and interpretability. However, cross-loadings within each set remain constrained to zero, which may lead to inflated factor correlations and biased estimates of specific factors [9].
Set-ESEM (Set Exploratory Structural Equation Modeling) permits cross-loadings within theoretically defined item sets (e.g., within functional or within critical items), while constraining cross-set cross-loadings to zero. This approach typically employs target rotation and strikes a balance between model realism and parsimony. Compared to CFA, it reduces inflation of factor correlations, and unlike full ESEM, it avoids over-permissiveness by preserving the theoretical structure of item types. Set-ESEM is particularly well-suited for modeling item heterogeneity but requires clear theoretical justification for the definition of item sets. However, it is less flexible than full ESEM when cross-set cross-loadings are substantively meaningful. [7], [9].
Set bifactor-ESEM extends Set-ESEM by adding a general factor. Items load on G and on set-specific factors, with cross-loadings allowed only within sets. It is ideal for hierarchical structures with heterogeneous item formats (e.g., functional behavioral items vs. critical knowledge items), capturing both general and specific variance while preserving theoretical separation between sets, enhancing discriminant validity and interpretability. Set bifactor-ESEM is more complex than Set-CFA or Set-ESEM. It requires adequate sample size, strong theory, and careful rotation specification [5], [9].

2.1 Why Set-Level Modeling Is Well-Suited to the yDSI

Digital competence is increasingly conceptualized as a multidimensional construct comprising both foundational operational abilities and higher-order evaluative capacities. Empirical and conceptual work reinforces a functional–critical distinction within this construct: Study [3] shows that functional skills support engagement with digital platforms, whereas critical skills guide judgment and strategic responses in complex digital environments. Another study [10] similarly classifies functional and critical literacies as distinct yet complementary categories within broader digital literacy models. The yDSI

formalizes this dual-layer structure by explicitly separating functional and critical aspects across its four skills domains, and its mixed item formats (behavioral vs. knowledge) justify set-level constraints that prevent cross-set contamination while allowing for within-set cross-loadings [2]. This measurement architecture aligns directly with Set-ESEM specifications and, for hierarchical modeling, with Set-bifactor ESEM, which enables estimation of a general digital competence factor spanning both sets while preserving domain-specific and set-specific variance [5], [9].
Meta-analytic work indicates that bifactor-ESEM families often provide superior fit and more trustworthy parameters than their CFA counterparts for educational constructs that are simultaneously general and domain-specific [6]. A study [11] identified a bifactor-ESEM solution as the most suitable representation of teachers' ICT competence beliefs, with a clear separation between the general factor and domain-specific components such as safety and collaboration.
The aim of this study is to determine whether functional and critical digital skills are represented as distinct yet interconnected domains of digital competence through the empirical modeling of the correlational structure of yDSI indicators using advanced analytic approaches, including the Set bifactor ESEM model. Alternative modeling strategies are compared to identify the most parsimonious and theoretically coherent representation of digital competence. Through the clarification of the relationship between functional and critical skill layers, the theoretical understanding of digital competence is refined, and more robust, evidence-based assessment and curriculum development in higher education are supported, ensuring that both skill sets are addressed in a balanced and pedagogically meaningful manner.

3. Method

3.1 Participants and Procedure

Data were collected from students at *Fan S. Noli University of Korça*, located in southeastern Albania. Participation was voluntary and anonymous, and responses were submitted via an online questionnaire, in full compliance with ethical standards approved by the Rector and university's Ethics Council.
The measurement instrument was based on the short version of the Youth Digital Skills Indicator (yDSI) [2] and included two sets. The first consisted of 24 items measuring functional digital skills across four dimensions: Technical and Operational Skills (TO), Information Navigation and Processing Skills (INP), Communication and Interaction Skills (CI), and Content Creation and Production Skills (CCP). These items were rated on a six-point Likert scale ranging from 0 (*I do not understand what you mean by this*) to 5 (*Very true of me*), with an additional option (*I do not want to answer*) coded as 99 and treated as missing value.
The second set comprised 9 items assessing critical digital skills across three dimensions: Information Navigation and Processing (INPC), Communication and Interaction (CIC), and Content Creation and Production (CCPC). These items used a four-category response format: 1 (*Definitely not true*), 2 (*Definitely true*), 3 (*I'm not sure*), and 99 (*I do not want to answer*), with the latter also treated as missing value. A total of 603 students participated (M_{age} = 22.07; *SD* = 5.72; years; 69.3% female). The sample size closely approximated the recommended minimum of 630 participants, as calculated using Soper's (2025) a priori sample size calculator for structural equation modeling [12]. This estimate was based on an anticipated effect size of 0.15, a desired statistical power of 0.80, and a model structure involving four latent and 24 observed variables.

3.2 Data Analysis

All models were estimated in Mplus (Muthén & Muthén) v. 8.11, using the Weighted Least Squares Mean and Variance adjusted (WLSMV) estimator, which is well-suited for ordinal data. WLSMV treats variables as categorical, uses polychoric correlations, and provides robust parameter estimates and standard errors even when normality assumptions are violated [7]. It is particularly effective for scales with five or fewer response categories and performs reliably with sample sizes over 200 [13], [14].
To assess the structural validity of digital competence, eight competing models were tested, including Full ICM-CFA, Full ESEM, Full bifactor-CFA, Full bifactor-ESEM, Second-order Set ICM-CFA**,** Set-ESEM**,** Set bifactor-CFA**,** and Set bifactor-ESEM.
Model fit was evaluated using χ^2, CFI, TLI, RMSEA (with 90% confidence interval), and SRMR, following established guidelines [15]. Thresholds for acceptable to excellent fit were defined as CFI/TLI ≥ .90/.95, RMSEA ≤ .08/.05, and SRMR ≤ .08. Given the chi-square test's sensitivity to sample size and model complexity, it was interpreted in conjunction with other indices [16].

4. Results

4.1 Model Fit Evaluation

Among the competing models, the Set bifactor-ESEM model (M8) demonstrated the most balanced and superior fit: χ^2 (368) = 729.47, RMSEA = .040 (90% CI: .036–.045), CFI = .994, TLI = .992, and SRMR = .022 (Table 1). These values meet or exceed conventional thresholds for excellent model fit.

Table 1. *Model fit for competing measurement models*

	Models	χ^2	df	RMSEA	90% CI	CFI	TLI	SRMR
M1	Full ICM-CFA	1362.968	474	.056	.052 .059	.986	.984	.044
M2	Full ESEM	716.867	318	.046	.041 .050	.994	.990	.021
M3	Full Bifactor-CFA	1426.246	462	.059	.055 .062	.985	.983	.043
M4	Full Bifactor-ESEM	621.322	292	.043	.039 .048	.995	.991	.019
M5	Set ICM-CFA 2 order	1317.458	487	.053	.050 .057	.987	.986	.045
M6	Set ESEM	940.023	402	.047	.043 .051	.992	.989	.025
M7	Set Bifactor-CFA	1482.861	482	.059	.055 .062	.984	.983	.051
M8	Set Bifactor-ESEM	729.468	368	.040	.036 .045	.994	.992	.022

Note. χ^2 - Chi-square; df - degrees of freedom; TLI - Tucker-Lewis Index; CFI - Comparative Fit Index; RMSEA - Root Mean Square Error of Approximation [90%CI]; SRMR - Standardized Root Mean Square Residual

Compared to other models, Set Bifactor-ESEM outperformed both traditional CFA-based models and fully exploratory ESEM variants (see Table 2).

Table 2. *Fit Index Differences Supporting Model Selection Based on Parsimony and Structure*

Model Comparison	$\Delta\chi^2$	Δdf	ΔRMSEA	ΔCFI	ΔTLI	ΔSRMR	Meet criteria
M2-M1	-646.101	-156	-.010	.008	.006	-.023	Yes
M3-M1	63.278	-12	.003	-.001	-.001	-.001	No
M4-M2	-95.545	-26	-.003	.001	.001	-.002	No/Yes
M6-M2	223.156	84	.001	-.002	-.001	.004	Yes
M6-M5	-377.435	-85	-.006	.005	.003	-.020	Yes
M7-M5	165.403	-5	.006	-.003	-.003	.006	No
M8-M4	108.146	76	-.003	-.001	.001	.003	No/Yes
M8-M7	-753.393	-114	-.019	.010	.009	-.029	Yes

For instance, the Set Bifactor-CFA model (M7) yielded higher RMSEA (.059) or SRMR (.051), and lower CFI (.984) or TLI (.983), indicating poorer fit and inflated error. When comparing Set Bifactor-ESEM (M8) with Full Bifactor-ESEM (M4), M8 showed better performance on RMSEA (.040 vs. .043) and TLI (.992 vs. .991), two indices that penalize for lack of parsimony. Although M4 slightly outperformed M8 on CFI (.995 vs. .994) and SRMR (.019 vs. .022), this pattern is identical to the findings reported by Marsh et al. (2011). They noted that Full-ESEM models may achieve slightly better fit on certain indices due to increased flexibility, but this often reflects capitalizing on chance, especially when the difference in chi-square is proportional to the difference in degrees of freedom.

4.2 Latent Structure and Factor Correlations

The Set Bifactor-ESEM model revealed low correlations between the general factors representing functional and critical digital skills (r = .29–.30), providing strong empirical support for their distinctiveness (Figure 1). In contrast, the Set Bifactor-CFA model produced substantially higher G-factor correlations (r ≈ .77), suggesting inflated overlap likely due to the restrictive assumption of zero cross-loadings. These findings reinforce the realism and flexibility of ESEM-based approaches in modeling multidimensional constructs. In the context of the Set B-ESEM solution, statistically significant cross-set correlations were detected solely among the INP and CCP sub-dimensions.

The choice of the best-fitting model reflects not only statistical fit but also adherence to theory, interpretability of parameter estimates, and parsimony, tempered by sample size considerations. When CFA and ESEM models yield similar fit and factor correlations, CFA may be preferred for its simplicity, especially in small samples. However, when ESEM models demonstrate substantially better fit and more clearly differentiated factors, they should be preferred.

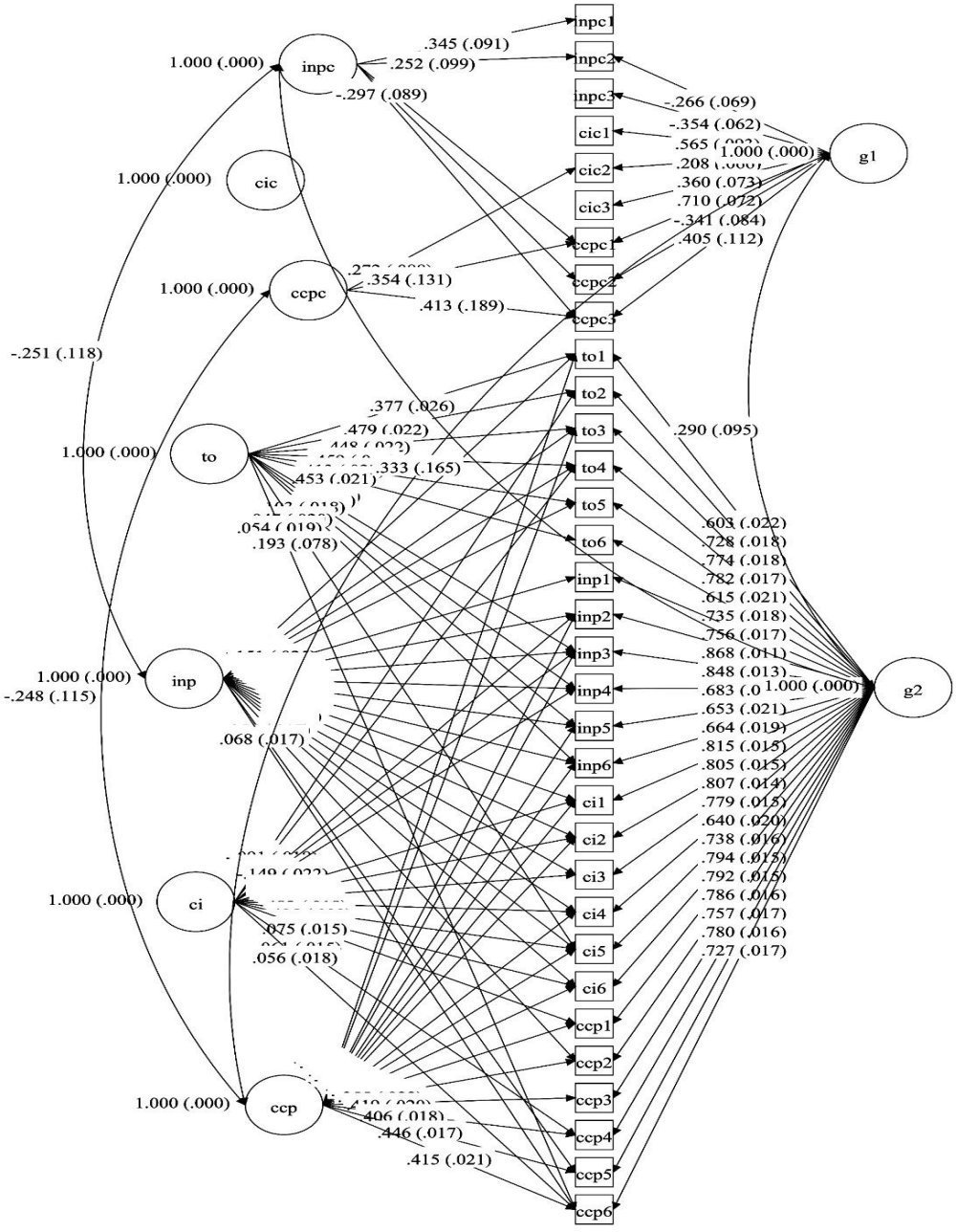


Fig. 1. *Standardized loadings (only statistically significant) of Set B-ESEM*

4.3 Structural Differentiation between Skill Domains

A closer inspection of item-level loadings revealed differential structural behavior between the two skill sets:

- For critical digital skills, the Set bifactor-ESEM model showed a dominance of the general factor, with most items loading significantly on G and relatively weak or non-significant loadings on their designated sub-factors. This pattern supports a unidimensional structure for critical skills under the constraints of the Set B-ESEM framework.
- For functional digital skills, the same model exhibited a more nuanced structure, where items loaded meaningfully on both the general factor and their respective sub-factors (e.g., TO, INP,

CI, CCP). This indicates a multidimensional configuration, with both general and domain-specific influences contributing to item responses.

In contrast, the Full bifactor-ESEM model revealed a more integrated structure across both domains. Specific factor loadings were stronger and more interpretable, and cross-loadings were present across items, suggesting a multidimensional latent structure overall. However, the general factor was less dominant for critical items, and the clarity of unidimensionality was reduced.

In summary, the Set bifactor-ESEM (Set B-ESEM) model offers the most accurate and theoretically sound representation of digital competence in this study. It confirms the hypothesized structure, reduces model bias, and adheres to best practices in multidimensional modeling by balancing statistical rigor with conceptual clarity.

The evidence supporting this conclusion includes:

- Low general factor (G-factor) correlations, indicating limited overlap across domains.
- Superior model fit of Set B-ESEM compared to alternatives.
- Distinct behavior across different item sets, reinforcing the need for a nuanced approach.

Together, these findings demonstrate that functional and critical digital skills are distinct yet interrelated domains, best captured through a parsimonious bifactor-ESEM framework, such as Set B-ESEM (see Table 3).

Table 3. *Modeling Approaches for Multidimensional Constructs: A Conceptual Comparison*

Model	Cross-loadings allowed	General factor included	Parsimony	Interpretability	Typical use case	Key advantage
Full ICM-CFA	No	No	High	Limited (rigid)	Simple, clean structures	Most parsimonious
Full ESEM	Yes (all)	No	Low	Complex	Multidimensional constructs	Realistic item behavior
Set-ESEM	Yes (within sets)	No	Moderate	Balanced	Distinct item sets (domains/methods)	Fit + structure preserved
Set B-ESEM	Yes (within sets)	Yes	Moderate	High	Hierarchical + item-type heterogeneity	General + specific variance, minimal bias

5. Discussion

This study aimed to evaluate the structural validity of digital competence by comparing eight competing measurement models, with particular focus on the bifactor-ESEM framework. The findings provide compelling evidence for the superiority of the Set bifactor-ESEM model, both in terms of statistical fit and theoretical interpretability. More importantly, the results offer nuanced insights into the distinctiveness between critical and functional digital skills, which has important implications for digital competence theory and assessment.

Structural Validity and Model Selection: The Set bifactor-ESEM model demonstrated excellent fit across all indices, outperforming both traditional CFA models and fully exploratory ESEM variants. Its balance between parsimony and flexibility allowed for a more realistic representation of the latent structure, avoiding the inflation of factor correlations commonly observed in ICM-CFA models. The low G-factor correlations (r = .29–.30) between critical and functional sets further support the hypothesis that these are distinct but related constructs, rather than manifestations of a single underlying dimension.

Within the Set B-ESEM model, a statistically significant association between functional and critical digital skills was identified only for the INP and CCP sub-dimensions. This pattern indicates that strengthening strategic (INP) and creative (CCP) functional digital skills may contribute to enhanced development of the corresponding critical digital skills linked to these domains. Such findings highlight the importance of supporting both layers of competence in an integrated manner, particularly in areas where functional proficiency has the potential to reinforce higher-order critical capacities.

Domain-Specific Structural Patterns: A key contribution of this study lies in the *differential structural behavior* observed across the two skill domains:

- For critical digital skills, the Set bifactor-ESEM model revealed a pronounced general-factor dominance: item loadings clustered on G, while specific-factor loadings were weak or non-significant. Such a configuration indicates that critical skills function as a unified construct, likely reflecting an overarching evaluative or judgment-based competency.

- Functional digital skills, however, exhibited a differentiated structure: items loaded substantively on their sub-factors while still contributing to the general factor. This pattern underscores the domain-specific and task-oriented nature of functional competence.

Emerging evidence supports this functional–critical distinction. Study [3] showed that functional and critical digital skills are mobilized differently in real-world civic action, reinforcing their conceptual separation. In contrast, the Full bifactor-ESEM specification in this study blurred these boundaries: although it increased specific-factor variance and enabled cross-loadings, it reduced the coherence of the general factor, especially for critical skills, highlighting a trade-off between flexibility and theoretical clarity.

Implications for Theory and Practice

These findings have several theoretical and practical implications:

1. *Clarifying the multidimensional architecture of digital competence:* The differentiated structure observed in Set bifactor-ESEM supports the conceptual separation between critical and functional digital skills, aligning with frameworks that treat digital competence as a multidimensional construct (e.g., [1], [3], [17]). This distinction helps refine existing frameworks by positioning functional skills as domain-specific operational abilities and critical skills as higher-order evaluative capacities grounded in reflective judgment.
2. *Strengthening construct validity through appropriate modeling:* Findings showing differential model performance (Set bifactor-ESEM vs. Full bifactor-ESEM) highlight the importance of choosing modeling structures that respect theoretical boundaries. The dominance of a general factor in the critical domain supports a unidimensional conceptualization, while the multidimensionality of functional skills confirms their domain-embedded nature. Theoretically, this suggests that digital competence is not a uniform construct but a hierarchical configuration that needs tailored representation.
3. *Advancing measurement theory in digital education research:* The results underscore that flexibility in measurement (e.g., allowing extensive cross-loadings) may undermine interpretability when constructs are expected to remain distinct. Theoretical work in digital competence should therefore prioritize models that balance complexity with conceptual clarity, ensuring that measurement aligns with pedagogically meaningful distinctions.
4. *Designing curricula that target both functional and critical layers:* Programs should intentionally integrate learning outcomes that build both:

- Functional skills: operational, technical, and domain-specific competencies (e.g., navigating platforms, managing information, producing content).
- Critical skills: evaluation, reflective judgment, bias recognition, ethical and safety-related reasoning.

Curricula must avoid treating digital competence as a monolithic skill and instead develop structured progression from functional to critical capacities.

5. *Supporting adaptive, evidence-based program design:* The hierarchical nature of digital competence indicates that:

- Foundational functional skills should be taught early (baseline operational literacy).
- Critical skills should be embedded across the curriculum as transversal competences.

This ensures students gradually move from tool-use proficiency to reflective digital citizenship and informed decision-making

6. Conclusion

This study provides empirical evidence that functional and critical digital skills form distinct yet interconnected layers of digital competence. Using Set bifactor-ESEM, we demonstrated that critical skills are best represented as a largely unidimensional construct, dominated by a general evaluative factor, whereas functional skills retain a multidimensional configuration aligned with domain-specific operational tasks. These structural differences reinforce contemporary theoretical work emphasizing the layered nature of digital competence and highlight the importance of selecting modeling approaches that respect established conceptual boundaries.

The results show that the Set bifactor-ESEM model provides a clearer and more interpretable structure of digital competence than more flexible alternatives. Although the Full bifactor-ESEM specification increased specific-factor variance, it weakened the coherence of the general factor, especially in the critical domain. Set bifactor-ESEM therefore emerges as the most theoretically aligned framework for

digital-skills assessment. These insights, in turn, support curricula that balance operational competence with evaluative digital judgment, reflecting the layered architecture of digital competence.
Overall, the findings enhance theoretical clarity around digital competence, validate more precise modeling strategies, and inform the development of curricula that better prepare students for evolving digital demands.

Limitations and Future Directions

While the Set bifactor-ESEM model provided the best representation of the data, its structure is partially constrained by theoretical assumptions. Future research should explore hybrid models that allow for partial cross-loadings while preserving interpretability. Additionally, longitudinal designs could help determine whether the structural distinction between critical and functional skills holds over time and across developmental stages.
The study relied on data collected from students at a single institution, a factor that may limit the generalizability of the findings.

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Shaping Future Learning through Digital-Skills Profiling

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Abstract

In contemporary knowledge societies, higher education institutions face a growing misalignment between the digital competence that graduates possess and the levels required by an increasingly digitalized labor market. Effective curriculum reform requires a theoretically coherent and methodologically rigorous understanding of digital skills as a construct and the heterogeneity with which these skills are distributed across student populations. Although digital skills are widely acknowledged as multidimensional and hierarchically structured, as reflected in conceptual frameworks such as DigComp, empirical studies addressing heterogeneity continue to rely on scale scores or factor scores derived from restrictive measurement models (e.g., Independent Cluster Model Confirmatory Factor Analysis, ICM-CFA), which fail to adequately capture the coexistence of global and specific dimensions and their interrelationships. Recent methodological advances emphasize the need to model digital skills using bifactor Exploratory Structural Equation Modeling (B-ESEM) and to use factor scores from such models as indicators in Latent Profile Analysis (LPA). This approach enables the clear disaggregation of level and shape differences, allowing for more meaningful, substantive, and interpretable student profiles. The present study aims to identify homogeneous subgroups of university students based on multidimensional digital skill patterns using LPA based on B-ESEM factor scores, and to contrast this approach with LPA solutions based on scale scores and ICM-CFA factor scores. Findings highlight the superior informational richness and classification accuracy of the B-ESEM-based profile solution, with meaningful implications for differentiated, targeted, and personalized curriculum design in higher education.

Keywords: *digital skills, curriculum design, latent profile analysis, bifactor-ESEM, higher education*

1. Introduction

European higher education systems face a growing mismatch between graduates' skills and the demands of increasingly digitalized labor markets. In response, digital competence is now widely regarded by policymakers as a foundational requirement for employability, economic resilience, and civic participation. Rapid technological change, driven by automation, artificial intelligence, data intensification, and hybrid work models, has made the effective use of digital information and tools essential across sectors.

Despite this recognition, digital skills remain unevenly integrated into higher education curricula. Treating them as optional or peripheral limits graduates' preparedness for contemporary work environments. At the same time, students differ substantially in their existing digital competencies due to variation in prior education, socioeconomic background, discipline, and learning trajectories. Uniform curricular solutions therefore risk inefficiency, either failing to support lower-skilled students or under-challenging more advanced ones.

From a policy perspective, effective curriculum reform requires evidence on how digital competencies are structured within student populations. Specifically, it is necessary to identify meaningful profiles that capture both overall levels of digital competence and distinct patterns of strengths and weaknesses across skill domains. Such knowledge enables targeted interventions, more efficient allocation of educational resources, and better alignment between higher education outcomes and labor market needs.

Established policy frameworks, particularly DigComp [1], conceptualize digital competence as a multidimensional construct comprising interrelated domains, alongside an overarching general competence. However, conventional measurement approaches often inadequately represent this structure, producing biased estimates that limit the value of subsequent analyses. When used for student profiling, such measures tend to capture only broad level differences, providing limited guidance for targeted policy action.

Recent advances show that pairing strong measurement models with person-centered methods produces more actionable insights. B-ESEM captures overall and domain-specific digital skills, and LPA transforms these results into clear competence profiles. This integrated approach strengthens the policy usefulness of digital-skills data and directly supports informed curriculum design.

2. Digital Skills as a Multidimensional and Hierarchical Construct

Contemporary conceptualizations define digital skills as a multidimensional construct extending beyond technical proficiency to include cognitive, communicative, creative, and evaluative capacities. This view mirrors the embedding of digital technologies in learning, employment, and professional practice.
The European Commission's DigComp framework formalizes this view by identifying several interrelated domains of digital competence. These domains function in a complementary manner, with competencies such as information literacy, communication, content creation, and safety mutually reinforcing one another.
This interdependence implies a hierarchical structure, consisting of an overarching level of general digital proficiency alongside domain-specific competencies that capture distinct patterns of strengths and weaknesses. Accurately representing this structure is essential for informing policy-relevant analyses and for designing targeted, efficient curriculum interventions.

2.1 Measurement Models for Capturing the Multidimensional Structure of Digital Skills

Accurately assessing digital skills requires measurement models capable of representing multidimensional item behavior. Traditional confirmatory factor analysis (CFA), grounded in the Independent Cluster Model [2], constrains cross-loadings to zero, despite substantial evidence that items often reflect multiple skill domains. For complex constructs such as digital skills, this assumption produces oversimplified representations and systematically biases parameter estimates [3, 4]. When true cross-loadings are suppressed, construct-relevant variance is misallocated, typically inflating factor correlations and distorting construct definitions [5].
This limitation highlights the need for models that explicitly account for multidimensional item structure. Exploratory structural equation modeling (ESEM) [6] addresses this issue by allowing theoretically guided cross-loadings under confirmatory control, better capturing the inherent overlap among digital skill domains. However, both CFA and ESEM lack the capacity to model hierarchical structures, leaving the coexistence of general and domain-specific competencies unrepresented.
Bifactor CFA models overcome this limitation by estimating a general factor alongside specific domain factors, enabling a clearer partitioning of shared and domain-specific variance [7]. Integrating bifactor modeling with ESEM yields bifactor ESEM (B-ESEM), which simultaneously models cross-loadings and hierarchical structure, offering a comprehensive framework for representing interconnected digital skills [8].
Methodological research recommends comparing CFA, ESEM, bifactor CFA, and B-ESEM to detect construct-relevant multidimensionality [9]. B-ESEM improves the validity of digital skills measurement by clearly separating general proficiency from specific skill domains.
Importantly, factor scores derived from B-ESEM provide a robust foundation for person-centered analyses, enabling the identification of student profiles that reflect both overall digital competence and distinct domain-level configurations.

2.2 Latent Profile Analysis

Latent Profile Analysis (LPA) [10] is a person-centered statistical methodology designed to identify homogeneous subgroups within a heterogeneous population based on individuals' scores on multiple continuous indicators. Unlike traditional cluster analysis, LPA is model-based and probabilistic, offering robust fit indices, classification accuracy measures, and replication tests that validate the extracted classes.

LPA equation is: $f(\mathbf{y}_i \mid \boldsymbol{\theta}) = \sum_{c=1}^{C} \boldsymbol{\gamma}_c f_c(\mathbf{y}_i \mid \boldsymbol{\mu}_c, \boldsymbol{\Sigma}_c)$, where, $f(\mathbf{y}_i \mid \boldsymbol{\theta})$, as the distribution of a set of scores y_i, given model parameters $\boldsymbol{\theta}$, is a function of the proportion of class c, $\boldsymbol{\gamma}_c$, and the class specific distribution, $f_c(\mathbf{y}_i \mid \boldsymbol{\mu}_c, \boldsymbol{\Sigma}_c)$, given its mean $\boldsymbol{\mu}_c$ and covariance metrics, $\boldsymbol{\Sigma}_c$.

Latent Profile Analysis (LPA) is widely used in psychology and education to identify unobserved subgroups that cannot be detected through variable-centered approaches. In educational research, LPA has been applied to motivation, engagement, well-being, and, more recently, students' digital behavior and digital competence.

Digital-skills LPA studies differ considerably in their use of item-level or aggregated indicators. While [11] is transparent about indicator choice, this clarity is often lacking elsewhere [12], hindering interpretation and comparison.

Despite their convenience, scale scores do not account for measurement error or reflect the underlying latent structure of digital competence. As a result, LPA based on scale scores tends to yield profiles driven primarily by overall level differences (e.g., low, medium, high), offering limited insight into domain-specific skill patterns. Methodological research therefore emphasizes that person-centered analyses should be grounded in robust variable-centered models that accurately represent construct multidimensionality [13].

Using factor scores derived from ICM-CFA only partially addresses this issue, as these scores remain constrained by restrictive assumptions, including zero cross-loadings. Such limitations can distort profile solutions and obscure meaningful qualitative differences. In contrast, bifactor ESEM generates factor scores that explicitly separate general and domain-specific components while preserving cross-domain information.

When B-ESEM factor scores are used in LPA, resulting profiles capture both level and shape differences, yielding richer and more interpretable classifications. This approach has been successfully applied in occupational and educational psychology to model complex psychological constructs [5, 14]. However, no published research has yet applied B-ESEM–based LPA to digital skills, despite their clearly demonstrated hierarchical and multidimensional structure.

***Purpose of the Study**:* Addressing this gap, the present approach identifies digital-skills profiles that capture both overall competence and distinct domain-level patterns. These differentiated profiles offer direct value for policy and practice, enabling targeted, adaptive, and evidence-based curriculum interventions. As such, B-ESEM–based LPA represents a significant methodological advance for digital-skills assessment and curriculum development.

This study demonstrates these advantages by showing that B-ESEM–derived profiles are psychometrically robust, theoretically coherent, and practically actionable, offering a strong foundation for more responsive and effective digital-skills curricula in higher education.

3. Method

3.1 Participants and Procedure

An online survey was administered via Google Forms to students across four faculties at Fan S. Noli University of Korça as part of a university-funded digital skills project. The sample included 599 students (69.3% female; *M* age = 22.09, *SD* = 5.75). Ethical approval was obtained from relevant institutional authorities, and participation was voluntary and anonymous.

The survey comprised socio-demographic items and the 24-item short Youth Digital Skills Indicator (yDSI; Helsper et al., 2020). The instrument was translated and culturally adapted through expert review. A preliminary test–retest evaluation with 30 students, administered three weeks apart, demonstrated good temporal stability (Spearman's $\rho \approx .80$).

3.2 Sample Size

Prior research suggests that 300–500 cases are adequate for stable Latent Profile Analysis solutions [15]. ESEM-based Monte Carlo simulations demonstrated adequate estimation quality, with standard error bias below 5% and MSE below .02 at $n = 350$. The final sample exceeded this threshold, supporting robust parameter estimation.

3.3 Measure

Students' digital skills were assessed using the validated 24-item Youth Digital Skills Indicator (yDSI) [16], covering four functional domains: Technical–Operational (TO), Information Navigation–Processing (INP), Communication–Interaction (CI), and Content Creation–Production (CCP). The problem-solving and safety domains were excluded due to conceptual overlap. Items were rated on a 0–5 scale; "prefer

not to answer" responses were treated as missing. The yDSI shows strong psychometric validity across multiple EU countries.

3.4 Data Analysis

All analyses were conducted in Mplus 8.11 (Muthén & Muthén). Three sets of LPA indicators were used: (a) summed scale scores for the four yDSI domains, (b) standardized factor scores from an ICM-CFA model, and (c) standardized factor scores from a bifactor ESEM model, identified in prior work as the best-fitting structure [17] among the CFA/ESEM configurations recommended for comparison [9]. Models were estimated using WLSMV, recommended for ordinal indicators and samples above 200 [18].

For each indicator set, two- to seven-profile LPA models were estimated using MLR with 1,000 random starts, 200 initial iterations, and 100 final optimizations, allowing means and variances to vary across profiles. Model selection followed standard multi-criteria guidelines [19], drawing on AIC, BIC, SABIC, entropy, smallest class percentage, and the adjusted Lo–Mendell–Rubin (aLMR) and Bootstrap Likelihood Ratio Tests (BLRT). BIC favored simpler models [20], entropy ≥ .80 signaled good accuracy [21], and classes <5% were viewed as potentially spurious unless theoretically meaningful [22]. The aLMR was interpreted cautiously due to instability, and the BLRT due to its sensitivity to minor likelihood improvements [23].

4. Results

4.1 Latent Profile Analysis Based on yDSI Sum Scores

LPA using the four yDSI sum-score indicators showed improved fit from the two- to five-class models, as indicated by decreasing AIC, BIC, and aBIC values (Table 1). Entropy remained high (.865–.914), with the three-class model showing the strongest classification (.914). The aLMR test supported only the two- and three-class solutions, whereas the BLRT remained significant across models but was interpreted cautiously due to its tendency to over-extract classes.

Table 1. *Fit Indices from Three Person-Centered Models*

Models	LL	nfp	SF	AIC	BIC	aBIC	Entropy	aLMR p-value	BLRT p-value
Model 1. LPA based on scale sum scores									
2 Profiles	-7383.508	17	1.3181	14801.016	14875.736	14821.766	.865	.0000	< .0001
3 Profiles	**-7082.979**	26	1.5598	14217.958	14332.235	14249.692	.914	.0008	< .0001
4 Profiles	-6916.025	35	1.5974	13902.049	14055.884	13944.768	.897	.0726	< .0001
5 Profiles	-6850.340	44	1.8198	13788.680	13982.071	13842.384	.897	.6260	< .0001
6 Profiles	-6801.404	53	1.7129	13708.807	13941.756	13773.496	.820	.6067	< .0001
7 Profiles	-6804.605	62	1.8033	13733.210	14005.716	13808.884	.893	1.0000	1.0000
Model 2. LPA based on ICM-CFA factor scores									
2 Profiles	-2800.148	17	1.1581	5634.297	5709.016	5655.046	.883	< .0001	< .0001
3 Profiles	-2366.445	26	1.3939	4784.890	4899.166	4816.624	.910	.0280	< .0001
4 Profiles	-2080.184	35	1.4657	4230.368	4384.202	4273.087	.949	.0021	< .0001
5 Profiles	-1874.478	44	1.4850	3836.957	4030.348	3890.661	.952	.0004	< .0001
6 Profiles	-1770.228	53	1.5150	3646.455	3879.404	3711.144	.951	.0466	< .0001
7 Profiles	-1773.546	62	1.3859	3671.092	3943.598	3746.765	.942	.1868	< .0001
Model 3. LPA based on B-ESEM factor scores									
2 Profiles	500.417	21	1.0873	-958.833	-866.533	-933.202	.956	< .0001	< .0001
3 Profiles	762.746	32	1.2774	-1461.492	-1320.844	-1422.435	.938	.0004	< .0001
4 Profiles	1039.443	43	1.4486	-1992.885	-1803.889	-1940.402	.927	.0119	< .0001
5 Profiles	1249.863	54	1.4580	-2391.726	-2154.382	-2325.817	.952	.0045	< .0001
6 Profiles	1039.443	65	0.9583	-1948.885	-1663.193	-1869.550	.944	.1109	1.0000
7 Profiles	1039.443	76	0.8196	-1926.885	-1592.845	-1834.124	.948	.1103	1.0000

Notes. LL = Model loglikelihood; nfp = number of free parameters; SF: scaling factor of the robust Maximum Likelihood estimator; AIC = Akaïke Information Criterion; BIC = Bayesian Information Criterion; ABIC = sample-size Adjusted BIC; ALMR: Adjusted Lo-Mendell-Rubin Likelihood Ratio Test; BLRT = Bootstrap Likelihood Ratio Test

Although the five-class model produced the lowest information criteria, it yielded fragmented (Table 2) and substantively weak classes, including very small groups and a non-significant aLMR.

Table 2. *Final class proportions for the latent classes based on estimated posterior probabilities for the three alternative models*

Model 1. LPA based on sum scores							
2 Profiles	.40690	.59310					
3 Profiles	.35467	.53461	.11073				
4 Profiles	.07689	.10870	.42045	.39395			
5 Profiles	.08140	.04759	.39141	.10759	.37201		
6 Profiles	.03250	.13954	.26008	.13636	.32402	.10750	
7 Profiles	.00712	.13363	.37338	.05719	.31624	.00498	.10746
Model 2. LPA based ICM-CFA factor scores							
Classes	C1	C2	C3	C4	C5	C6	C7
2 Profiles	.31781	.68219					
3 Profiles	.24331	.56366	.19303				
4 Profiles	.25466	.12797	.03829	.57908			
5 Profiles	.07524	.22520	.53816	.03829	.12311		
6 Profiles	.02666	.12218	.22081	.06268	.52938	.03840	
7 Profiles	.03170	.50304	.20718	.03829	.00334	.09585	.12060
Model 3. LPA based on B-ESEM factor scores							
2 Profiles	.73174	.26826					
3 Profiles	.20519	.27867	.51614				
4 Profiles	.22098	.41851	.26259	.09792			
5 Profiles	.03657	.34839	.30011	.09791	.21702		
6 Profiles	.41851	.09792	.22098	.00000	.26259	.00000	
7 Profiles	.26259	.41851	.00000	.00000	.22098	.09792	.00000

Thus, only the three- and four-class models were considered viable (Table 3).
In the three-class solution, Class 1 (35.47%) showed uniformly low digital skills; Class 2 (53.46%) showed moderate but even skill levels; and Class 3 (11.07%) showed high skills, especially in CI and CCP.
In the four-class solution, three classes differed only in magnitude, and the additional class did not offer conceptual distinction, with one class mean not reaching statistical significance.
Balancing fit indices, parsimony, aLMR results, class size, and interpretability, the three-class model provided the most coherent and theoretically meaningful representation of heterogeneity in digital skills based on yDSI sum scores.

4.2 Latent Profile Analysis Based on ICM-CFA Factor Scores

LPA based on the four ICM-CFA factor scores showed improving fit from the two- to five-class models, with decreasing AIC, BIC, and aBIC values and consistently high entropy (.883–.952). The aLMR test supported solutions up to five classes but not beyond, while the BLRT remained significant across all models (Table 1).
Among the three-, four-, and five-class solutions (Table 3), the three-class model reflected only quantitative differences: a very low-skill class (24.33%), a moderate-skill class (56.37%), and a high-skill class (18.87%), all showing uniform patterns across dimensions. However, the lowest-skill class had a non-significant mean, limiting its distinctiveness.
The four-class solution largely replicated the three-class structure but introduced a small (3.83%) subgroup with exceptionally high INP and CCP scores, representing a distinct high-performing group.
The five-class model added a meaningful low-performing subgroup (7.52%) with deficits across all domains, including TO dimension. All latent means were statistically significant, and the remaining classes aligned closely with those in the four-class solution.
Considering statistical fit, aLMR and BLRT support, high entropy, and the substantive value of distinguishing both an advanced and a very low-performing subgroup, the five-class solution provided the most informative representation of heterogeneity in the ICM-CFA factor scores.

4.3 Latent Profile Analysis Based on Bifactor ESEM Factor Scores

Using bifactor ESEM factor scores, the LPA incorporated both a general digital-skills dimension (quantitative variation) and four specific dimensions capturing qualitative differences across domains. Fit indices improved steadily from the two- to five-class models, with decreasing AIC, BIC, and aBIC values and high entropy (.927–.956). The aLMR and BLRT test supported up to five classes, while nonsignificant results for larger solutions, along with fragmented and near-empty classes (Table 2), indicated over-extraction.

Table 3. *Standardized latent class means for the competing profiles across the three approaches*

LPA based on scale sum scores										
3 Profiles										
Means	C1	p-value	C2	p-value	C3	p-value				
TO	2.356	.000	5.901	.000	15.120	.000				
INP	2.703	.000	5.241	.000	11.584	.000				
CI	2.330	.000	6.864	.000	85.721	.000				
CCP	2.586	.000	5.859	.000	45.747	.000				
4 Profiles										
Means	C1	p-value	C2	p-value	C3	p-value	C4	p-value		
TO	4.196	.000	15.264	.000	7.352	.000	3.142	.000		
INP	2.878	.000	11.601	.000	6.147	.000	3.559	.000		
CI	3.778	.000	88.818	.004	8.380	.000	2.932	.000		
CCP	3.672	.000	47.125	.000	7.274	.000	3.045	.000		
5 Profiles										
Means	C1	p-value	C2	p-value	C3	p-value	C4	p-value	C5	p-value
TO	4.282	.000	13.340	.000	3.540	.000	15.301	.000	8.002	.000
INP	2.794	.000	6.664	.000	3.722	.000	11.570	.000	6.614	.000
CI	3.082	.000	6.999	.000	3.174	.000	91.281	.230	9.138	.000
CCP	3.592	.000	7.816	.019	3.140	.000	48.009	.064	7.942	.000
LPA based on ICM-CFA factor scores										
3 Profiles										
Means	C1	p-value	C2	p-value	C3	p-value				
TO	-2.171	.000	0.057	.787	2.800	.000				
INP	-2.252	.000	0.092	.614	2.231	.003				
CI	-2.490	.000	0.130	.474	2.292	.000				
CCP	-2.426	.000	0.109	.518	2.335	.007				
4 Profiles										
Means	C1	p-value	C2	p-value	C3	p-value	C4	p-value		
TO	-2.083	.000	3.487	.000	1.193	.017	0.246	.005		
INP	-2.166	.000	3.035	.000	67.514	.003	0.236	.015		
CI	-2.392	.000	4.154	.004	26.442	.000	0.270	.004		
CCP	-2.327	.000	4.204	.000	78.746	.002	0.237	.016		
5 Profiles										
Means	C1	p-value	C2	p-value	C3	p-value	C4	p-value	C5	p-value
TO	-8.213	.000	-1.852	.000	0.341	.000	1.193	.017	3.640	.000
INP	-4.503	.000	-2.248	.000	0.356	.000	67.508	.003	3.125	.000
CI	-5.455	.000	-2.027	.000	0.379	.001	26.441	.000	4.461	.000
CCP	-6.401	.000	-2.642	.000	0.369	.000	78.745	.002	4.347	.000
LPA based on B-ESEM factor scores										
4 Profiles										
Means	C1	p-value	C2	p-value	C3	p-value	C4	p-value		
G	1.148	.000	-1.350	.000	0.748	.000	1.978	.001		
TO	11.018	.000	29.643	.000	69.238	.000	5.820	.000		
INP	0.423	.000	-0.155	.031	-0.515	.000	1.000	.000		
CI	10.996	.000	27.908	.000	87.791	.000	13.967	.000		
CCP	-0.024	.787	-0.020	.773	-0.015	.878	0.315	.053		
5 Profiles										
Means	C1	p-value	C2	p-value	C3	p-value	C4	p-value	C5	p-value
G	-34.353	.004	0.441	.000	-1.987	.000	1.978	.001	0.996	.000
TO	170.760	.008	51.487	.000	43.076	.000	5.818	.000	10.771	.000
INP	-1.805	.000	-0.427	.000	-0.100	.217	1.001	.000	0.496	.000
CI	101.058	.002	62.818	.000	35.534	.000	13.976	.000	11.231	.000
CCP	-0.121	.614	0.000	.999	-0.025	.763	0.315	.053	-0.037	.679

Both the four- and five-class models showed significant latent means. The four-class model demonstrated strong fit, high entropy (.927), significant aLMR and BLRT values, and no classes below 5%. In this solution, 41.85% of students scored below average on the general factor, while nearly 10% showed stronger general and specific digital skills (Table 3).

The five-class model achieved the lowest information criteria and excellent entropy (.952), but included a small class (3.63%), below recommended stability thresholds. Despite its size, this class provided meaningful insight by illustrating how severe INP deficits can substantially depress overall digital competence. The remaining classes were interpretable, distinct, and adequately sized.
Balancing statistical fit, class stability, and substantive interpretability, the five-class bifactor ESEM solution was identified as the optimal profile structure.

5. Discussion

This study compared three latent profile analysis (LPA) strategies for identifying heterogeneity in students' digital competence: (a) yDSI sum scores, (b) ICM-CFA factor scores, and (c) bifactor ESEM factor scores. Although all approaches produced statistically adequate solutions, the B-ESEM–based LPA generated the most informative and educationally meaningful profiles because it simultaneously captured *overall digital skill levels* and *qualitative differences across specific domains*. This dual perspective provides a depth of interpretation not attainable with sum scores or ICM-CFA models.

***Limitations of Sum Score and ICM-CFA Approaches*:** LPAs based on yDSI sum scores and ICM-CFA factor scores primarily detected *quantitative* variation, producing "low–medium–high" profiles with minimal differentiation across TO, INP, CI, and CCP. While statistically acceptable, these solutions reflect a single continuum of ability and offer limited insight for targeted curriculum design.
The ICM-CFA approach added nuance by identifying two small but meaningful subgroups: a high-performing group distinguished by strong INP and CCP skills, and a vulnerable group with very low competence across all domains. While these findings support differentiated teaching, the profiles did not reveal qualitative patterns because the ICM-CFA model constrains both cross-domain relationships and hierarchical structure.

***Advantages of the B-ESEM–Based LPA*:** The B-ESEM approach substantially improved profile interpretability by modeling both the general digital-skills factor and domain-specific qualitative variation. Controlling for overall ability exposed meaningful differences in INP and CCP that were masked in the previous models. The resulting profiles combined level and shape differences, offering deeper insight into how students' strengths and weaknesses interact.
Notably, B-ESEM revealed that strategic (INP) and creative (CCP) skills exert disproportionate influence on overall competence. Students with severe INP deficits displayed sharply lower general scores, while profiles with strong CCP performance showed elevated digital proficiency. These distinctions, central for curriculum design, are uniquely identifiable through B-ESEM.

***Why the B-ESEM Approach Is Optimal*:** The B-ESEM–based LPA offered the strongest combination of statistical fit, class stability, conceptual clarity, and policy relevance. It simultaneously captured quantitative differences in students' overall digital competence and qualitative variation across the four specific dimensions, producing distinct and interpretable subgroups that reflect realistic digital-skill configurations. Although two classes in the ICM-CFA and B-ESEM solutions fell below the conventional 5% threshold, both yielded meaningful substantive insights, suggesting that such cutoffs should not be applied rigidly when small groups represent genuine educational needs.

Implications for Targeted and Differentiated Curriculum Design
The B-ESEM profiles provide direct guidance for evidence-based curriculum improvement. The identification of INP and CCP as key differentiators among high-performing students suggests curricula should incorporate activities that strengthen information evaluation, synthesis, complex problem-solving, and creative content production. These components align closely with contemporary digital-literacy frameworks.
Conversely, the detection of a subgroup lacking foundational digital skills highlights the need for remedial, scaffolded instruction focused on operational tasks, safety practices, and structured digital routines. Without such support, these students risk marginalization in digital learning environments and future labor markets.
Because B-ESEM profiles include both level and shape information, they offer a strong foundation for tiered, adaptive, and personalized curriculum pathways. Institutions can design differentiated learning trajectories that match students' strengths, address specific deficits, and allocate resources strategically.

This stands in clear contrast to “one-size-fits-all” curricula that overlook substantial within-population variability.

6. Conclusion

By comparing three modeling strategies, this study demonstrates that B-ESEM–based LPA provides the most powerful method for uncovering meaningful digital-skills heterogeneity. By separating general competence from specific qualitative dimensions, B-ESEM offers diagnostic precision that raw scores and ICM-CFA models cannot achieve.
The identification of INP and CCP as critical drivers of overall digital ability, and the detection of both high-performing and at-risk subgroups, provides actionable evidence for curriculum modernization. These insights support institutional strategies that embed digital skills in a differentiated, targeted, and personalized manner. Accordingly, the B-ESEM approach not only advances methodological practice but also provides a strong empirical basis for equitable and responsive digital-skills policy and curriculum design within higher education.

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Scalability by Design: Leveraging DACUM and AI to Standardize Implementation Fidelity in Global Educational Interventions

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Abstract

This research addresses the challenge of sustainable scalability in educational interventions by focusing on implementation fidelity as the cornerstone for success. The study argues that scientific precision in defining facilitator tasks is essential to replicate impact without compromising effectiveness. Utilizing the DACUM methodology, the author deconstructed staff responsibilities into measurable tasks to bridge the gap between theoretical models and classroom practice.
The study involves the validation of a monitoring instrument for Asociación Grupo Ceiba. Psychometric analyses, including Classical Item Analysis and Exploratory Factor Analysis, confirm the instrument is reliable and valid for assessing consistency. The findings also highlight Artificial Intelligence as a valuable tool for generating item banks, provided they undergo expert validation. Ultimately, this work provides a robust framework to ensure educational interventions remain effective as they scale.

Keywords: *Implementation fidelity, DACUM methodology, scalability, educational monitoring, psychometric validation, Artificial Intelligence.*

1. Introduction

The success of a high-quality educational intervention lies not only in its local results but also in its scalability; that is, its ability to replicate its impact on a large scale without compromising its original effectiveness [13]. However, this expansion process faces a critical challenge: ensuring that implementers faithfully execute the model while maintaining the flexibility needed to make appropriate adaptations to each context. In this sense, the sustainability of an intervention depends directly on the consistency and quality of its implementation over time and across different locations [4].
To achieve this balance, it is imperative to define with scientific precision what those responsible for implementing the program should do. This research argues that the foundation of successful implementation lies in a rigorous analysis of the responsibilities and tasks of the staff, specifically the teacher or facilitator, who acts as the final link in the delivery of educational services to the beneficiary [4].
Defining tasks is insufficient without a mechanism to verify the consistency of their implementation across different locations and over time. This technical need requires the design of a monitoring instrument that serves as an empirical bridge between the theoretically conceived educational model and teachers' practice. For this instrument to be a legitimate tool for decision-making, it must meet the criteria of validity and reliability [8].
Therefore, this research focuses on piloting and validating the monitoring instrument for the implementation of the flexible education model of Grupo Ceiba. This study used the **DACUM** (*Developing A Curriculum*) methodology as a starting point to break down the specific competencies and tasks of the facilitator within an educational model. Artificial Intelligence (AI) was also used for the comprehensive generation of observation items for the instrument.
Within this framework, the instrument's validity is based on the results derived from the DACUM process, ensuring that the items accurately represent the model's elements. Additionally, its reliability relies on translating these elements into observable tasks, allowing for an objective, consistent, and verifiable measurement of facilitators' performance in the field. This research demonstrates the validation of an instrument for monitoring the implementation fidelity of Grupo Ceiba's flexible education model through its group of facilitators.

1.1 Implementation Fidelity and Sustained Scalability

One of the fundamental premises for scaling an educational innovation is its proven effectiveness. However, when an innovation is not implemented as intended, the likelihood of it failing to achieve the expected results is high. This phenomenon underscores the critical need to measure the degree of implementation fidelity before proceeding with any scaling efforts. An innovation may appear ineffective when the underlying problem is low fidelity, which raises doubts about the true causality of the results obtained [7].
Implementation fidelity is defined as the degree to which a practice is carried out according to the intended model, under the assumption that the success of any educational change depends on precise execution [7]. This concept is multidimensional and encompasses five key dimensions: dosage, adherence, responsiveness, quality, and differentiation. Of these, "quality" is particularly relevant to this research, as it includes the capacity for adaptive or flexible implementation depending on the context, evaluating the performance of the facilitator. Other dimensions analyze adherence to the model's components, the dosage of intervention received, user satisfaction, and the impact of the program's added value.
To measure these dimensions, especially in a complex educational model, subjective reports are insufficient. Century, Rudnick, and Freeman (2010) argue that direct observation is the most reliable and valid method for measuring fidelity, distinguishing between structural and instructional components [4]. However, for the observation to be rigorous, fundamental methodological questions arise: **what exactly will be observed in a facilitator while implementing the educational model? And are we confident that we are measuring implementation consistently and valid?**
It is at this point that the present research introduces the analysis of work tasks using the DACUM methodology. To answer the question of the degree of adaptive implementation of the educational model, it is imperative to break down the implementer's functions into observable tasks. The DACUM process provides the scientific basis for the validity of the measurement instrument, ensuring that what is observed at the sites coincides with the critical components of the original design. Furthermore, transforming these functions into concrete behavioral items ensures the reliability necessary to determine whether the variations at each site are valid pedagogical adaptations or deviations from the model.

1.2 The DACUM Method

The DACUM (*Developing A Curriculum*) methodology is based on a pragmatic and collaborative approach to occupational analysis, starting from the premise that expert workers are the professionals best qualified to define their own work. This method posits that any occupation can be accurately described by identifying the specific tasks performed by successful workers, recognizing that each of these actions demands particular knowledge, skills, and attitudes for its effective execution. Under this "learning by doing" philosophy, the process takes place in an intensive workshop where a panel of 5 to 12 experts, under the guidance of a facilitator, breaks down the occupation into general functions and measurable tasks. The final result is a detailed competency map that translates work experience into a structured job profile, which serves as a scientific basis for the design of training programs, intervention monitoring, and performance evaluation systems [14].
The DACUM method offers significant competitive advantages over traditional occupational analysis methods, such as direct observation or individual interviews. One of its main strengths is its time and cost efficiency, as it allows for the consolidation of data in just two days of group work, whereas other methods would require weeks of data collection [14]. Furthermore, by relying on a panel of experts currently performing the work, the method ensures superior content validity, capturing the real behaviors and tasks demanded by the labor market, in contrast to academic approaches that tend to become outdated quickly [9]. Finally, the collaborative nature of the process fosters immediate consensus and a sense of ownership among employers and educational institutions, facilitating a smoother transition from curriculum design to on-the-job implementation [5].

1.3 Analysis of the Nature of the Tasks: Complexity and Difficulty

In the study of human performance, tasks are defined as the fundamental activities that individuals must perform to progress in both their personal and professional lives [11]. The literature has shown that the intrinsic characteristics of these tasks not only condition job performance but also shape an individual's social behavior [11]. One of the most critical variables for classifying these activities is their complexity.

Highly complex tasks place substantial demands on the performer's skills, knowledge, cognitive functions, and memory [11]. Therefore, to determine whether performance in an intervention is satisfactory, it is imperative to analyze the relationship between task complexity and the outcome, allowing us to establish whether the observed performance aligns with the expected performance.
Several authors have attempted to define cognitive complexity from multiple dimensions. Wood (1986) proposes a tripartite model [17]:

- **Component Complexity:** Refers to the volume of different acts and information signals that must be processed.
- **Coordinative Complexity:** Linked to the nature of the relationships between inputs and final products.
- **Dynamic Complexity:** Originating from the variability of the environment that alters these relationships.

Other theoretical frameworks have expanded on this view. Campbell (1988) identifies the presence of multiple paths and outcomes, conflicting interdependence, and uncertainty in relationships as sources of complexity [7]. Bonner (1994), for his part, articulates complexity around information processing (input, process, and outcome), emphasizing the quantity and clarity of information [7]. Finally, Harvey and Koubek (2000) extend Wood's work by proposing dimensions of scope, structure, and uncertainty [7]. Taking together, these perspectives reinforce the idea that the quantity, interaction, and variation of the elements of a task are the main determinants of its complexity.
It is essential, however, to distinguish between task complexity and difficulty, concepts often used interchangeably in literature but considered distinct in this research. This paper proposes a critical conceptual distinction: complexity is an inherent property of pedagogical design (the 'what' and 'how' of the educational model of Grupo Ceiba), while difficulty is redefined as operational feasibility ('how frequent'). Thus, while complexity is stable and depends on the design, difficulty is variable and depends on the individual's interaction with their work environment, moving away from the traditional view that subordinates it solely to the subject's perception of self-efficacy.
This distinction between complexity and difficulty underscores the importance of a thorough occupational analysis. In the context of Grupo Ceiba's flexible education model, the facilitator's tasks are highly complex, as the intervention requires not only following a protocol (elements of the educational model) but also adapting information to the student's changing environment (uncertainty). Furthermore, difficulty, understood as feasibility, depends largely on contextual factors.

1.4 The Use of AI to Develop Standardized Instrument Items

The integration of Artificial Intelligence (AI) into the development of items for standardized instruments represents one of the most dynamic frontiers in contemporary psychometrics, as highlighted at the 2026 NCME (National Council on Measurement in Education) conferences. The use of artificial intelligence allows for the automatic generation of items at an unprecedented scale and speed, facilitating the creation of extensive item banks and reducing the risk of content exposure [2;12]. However, recent NCME research emphasizes that this potential must be balanced with strict psychometric rigor; authors such as Hao et al. (2024) and Bulut et al. (2024) warn of the need for "responsible AI" frameworks to mitigate algorithmic bias and ensure construct validity [10; 3]. In this sense, it is proposed that AI should not replace, but rather enhance the work of content experts, using *prompt engineering* and semantic alignment strategies to ensure that the generated items maintain the necessary relevance and fairness in large-scale evaluations [16].

2. Methodology

This research is based on a psychometric instrumental design, aimed at developing and validating an instrument to measure the fidelity of implementation in the Grupo Ceiba educational model. The procedure integrates the DACUM occupational analysis for content delimitation, Haladyna 's (2006) guidelines for scale construction [8], and Shoukri 's (2010) criteria for reliability analysis, item analysis, and internal structure of the instrument [15].

2.1 Participants

The study was conducted in collaboration with the Grupo Ceiba Association of Guatemala. Technical validation and piloting were carried out with the 53 Grupo Ceiba facilitators who implement a flexible educational model at their respective locations up to January 2026. Additionally, a panel of experts,

comprised of 8 to 12 facilitators with more than 3 years of experience and regional coordinators from the institution, participated in the DACUM workshop.

2.2 Instrument Development Procedure

Following the test development cycle proposed by Haladyna (2006), the process was structured in five validation phases [8]:

Phase 1: Domain Definition and Content Validity. To ensure that the instrument accurately represents the essential element of the original design of the educational model, an intensive workshop was conducted using the DACUM (*Developing A Curriculum)* methodology. In this phase, the panel of experts broke down the facilitator's role in general responsibilities and specific, measurable tasks. This process translated the facilitator's role into measurable responsibilities and tasks, ensuring content validity from the design's foundation. Subsequently, these tasks underwent a validation survey to determine their frequency and importance, yielding a criticality index for each. The criticality index is a metric used to rank elements (tasks) based on their frequency of implementation and importance within the educational model [6].

Phase 2: Specification table and item construction. Based on the criticality index, a specification table was developed to determine the number of observation items to be included in the observation instrument, distributed according to the estimated criticality for each one.

Table 1. Table of Specifications

Area of responsibility of the facilitator	Number of items according to criticality index to be included in the instrument
Pedagogical agreement	14
Administration	9
Assessment	7
Monitoring	8
Maintenance	1
Divulgation	8
Total	47

Phase 3: Exhaustive generation of possible items to observe in a facilitator. Once the table of specifications was developed, items were generated, worded as observable actions. For this, the artificial intelligence tool Google Gemini was used, and it was asked to suggest all possible ways to observe each task on the task map obtained in the DACUM workshop, without any limit. In the process of requesting the item bank from Gemini, the document containing the educational model of Asociación Grupo Ceiba [1] was provided as part of the prompt. This bank resulted in 316 possible items to include in the questionnaire.

Phase 4: Instrument assembly. From the bank generated in Phase 3, the final items were randomly selected, respecting the proportionality indicated in the specifications table of the previous step (Haladyna, 2006). However, the Grupo Ceiba team that validated the instrument suggested, including only 44 items as three were considered to be redundant. The table shows the total number of items. The instrument is structured using a four-level frequency scale that allows for the assessment of facilitator performance, ranging from "never does it" (1) to "always does it" (4), with intermediate levels of "does it occasionally" (2) and "does it frequently" (3). The final instrument consists of 44 items organized into six job responsibilities (theoretical dimensions), which were directly derived from the key responsibilities identified during the DACUM workshop and further in the table of specification (Table 1).

Phase 5: Piloting the instrument. To strengthen objectivity and mitigate observational bias, a multi-informant evaluation scheme (triangulation) was adopted while piloting the final instrument: (a) the regional coordinator, (b) a student with at least one year of experience, and (c) the facilitator themselves through self-evaluation. The instrument was configured for direct evaluation by the coordinators, based

on their frequent visits to the sites. The facilitators responded based on a self-evaluation, and the students based on their experience as students of the facilitator for at least one year.

2.3 Data Analysis

The psychometric quality of the instrument was analyzed under the following criteria:

2.3.1 Item Analysis

An initial exploration was conducted using the frequency distribution of the scale options: "never does it" (1), "does it occasionally" (2), "does it frequently" (3), "always does it" (4) . Subsequently, internal consistency was estimated using Cronbach's alpha coefficient, with the psych package in the R statistical environment.

2.3.2 Internal Structure

To assess construct validity, an exploratory factor analysis (EFA) was performed using the psych package in the R statistical environment. The purpose of this analysis was to verify that the empirical structure of the tasks corresponded to the theoretical dimensions of facilitator responsibilities as defined in the Dacum Workshop and further in the table of specifications (Table 1).

2.3.3 Implementation Fidelity Exploration

Finally, the facilitators' overall scores were estimated, disaggregated by the three profiles of actors participating in the study, to compare the reported implementation levels.

3. Results of the Instrument Validation

3.1 Item Analysis

Analysis of the response frequencies reveals a marked tendency towards the higher categories on the scale: **"I always do it" (4)** and **"I do it frequently" (3).** The category **"I do it occasionally" (2)** has a significantly lower frequency, while the option **"I never do it" (1)** is selected marginally.
This distribution suggests that, while the four-level scale effectively discriminates the degree of implementation among those already applying the model, it has a limited capacity to identify those who have not implemented it at all (ceiling effect). Consequently, calculating the implementation fidelity score is the proportion of frequency of implementation over complete implementation of the task.

Table 2. Average proportion of selection of each point on the scale

	Number of items	I never do it	I do it occasionally	I do it frequently	I always do it
Pedagogical agreement	14		4.6363	44.7357	47.8429
Administration	8	1.9	5.6857	37.5222	54.0889
Assessment	7		3.04	45.2857	48.7857
Monitoring	7	6.3	7.5571	47.9857	38
Maintenance	1		1.9	20.8	73.6
Divulgation	6	1.9	6.9333	39.3	49.6667

The 44-item scale exhibits excellent internal consistency, with an overall Cronbach's alpha coefficient of 0.96 [0.95, 0.96]. Item homogeneity is adequate, with an average inter-item correlation of 0.33. The reliability analysis if one item is removed (Reliability if an item es The deleted items demonstrate that excluding any item would not significantly increase the overall coefficient, suggesting that all items contribute positively to the consistency of the construct. Furthermore, all corrected item-total correlations exceed 0.40, confirming the strong discriminatory power of each item within the scale.

3.2 Factor Analysis

Exploratory factor analysis confirms the existence of a robust general implementation factor underlying the entire instrument (MR1). However, specific dimensions are identified that group teachers' practices around pedagogical agreements and administrative practices (MR3); items from sections A (A_2_12_D, 0.648) and B (B_4_32_D, 0.551) load here. Monitoring and administrative tasks (MR4) are also included; items from section D, such as D_2_11_D (0.658) and B_1_6_D (0.624), load heavily here. Finally, evaluation (MR2) is defined by items C_1_6_D (0.600) and C_3_24_D (0.501). The presence of cross-loadings suggests that the Grupo Ceiba educational model functions as an integrated system where the components mutually reinforce each other. This finding is consistent with the literature on the dynamic complexity of work tasks.

Table 3. Factor Loads

FACTORIAL DIMENSION	LOAD	DESCRIPTION OF (MR)
MR1: GENERAL IMPLEMENTATION	Dominant	Robust factor that underlies the entire instrument.
MR3: PEDAGOGICAL AGREEMENT	0.648	Pedagogical agreement and administrative tasks.
MR4: MONITORING	0.658	Monitoring and administrative tasks.
MR2: EVALUATION	0.600	Evaluation tasks.

3.3 Implementation Fidelity

To estimate the implementation fidelity results, fidelity of implementation of the facilitators scores as evaluated by three people were obtained: 1) the coordinator (immediate supervisor), 2) their students, and 3) themselves in a self-evaluation format.

With 95% confidence, the implementation fidelity according to the facilitators' self-assessment falls between CI (0.83, 0.88). With the same confidence level, the students find a slightly higher implementation fidelity CI (0.88, 0.92). Finally, the coordinators find a level of implementation fidelity very close to the facilitators' self-assessment CI (0.81, 0.87). The graph shows that the coordinators' evaluations of the facilitators vary more than the self-assessments and the students' evaluations. Presumably, this is because the coordinators can compare the work of several facilitators under their supervision. In all three cases, implementation of fidelity exceeds 80%.

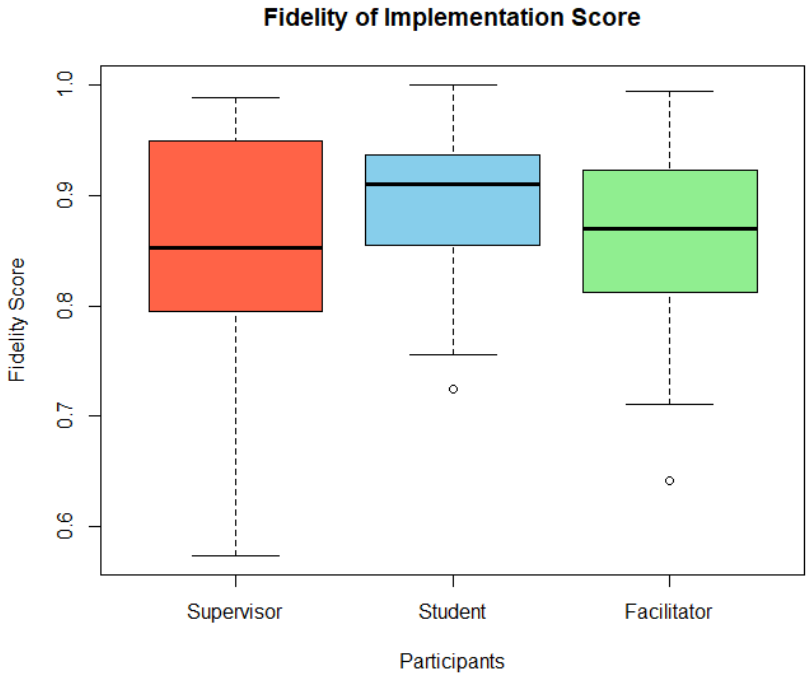


Fig. 1. Average score per group of participants

4. Conclusions

The validation process for a monitoring instrument, initially based on task analysis using the DACUM methodology, ensures that the measurement will focus on the specific operational aspects of the intervention. In this sense, designing tools with a focus on faithful implementation is essential for project sustainability, as it enables informed decision-making and continuous, evidence-based improvement.
Under this rigorous methodology, the analyses performed confirm that the resulting monitoring instrument is reliable and valid, meeting the necessary psychometric properties to ensure that the fidelity of its implementation is based on precise measurements. In the item construction phase, the use of Artificial Intelligence emerges as a valuable tool for generating a comprehensive item bank; however, its application must be strictly subject to the model's normative documents and undergo qualitative validation with the intervention's leadership to ensure its relevance.
Finally, the results of this study suggest that, discriminating against response frequency in certain categories, it is essential to preserve a scale that includes at least three levels of performance: one that documents the absence of implementation and two that allow discriminating the gradation of the model's presence in the work context.

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Global Learners, Global Leaders: Building the Knowledge, Empathy, and Skills to Lead in an Interconnected World

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Abstract

Global Learners, Global Leaders is an elementary-level program designed to cultivate globally competent students through an integrated approach that combines language learning, cultural exploration, and engagement with the United Nations Sustainable Development Goals (SDGs). As globalization increasingly shapes social, environmental, and economic systems, education must equip young learners with the knowledge, skills, and dispositions necessary to understand diverse perspectives and address complex global challenges. Global competence involves the ability to examine issues of local and global significance, communicate across cultures, and take informed action toward sustainable and inclusive societies (Organisation for Economic Co-operation and Development [OECD], 2018). Today's students are tomorrow's problem-solvers. This program encourages elementary learners to explore the world with curiosity, empathy, and a sense of shared responsibility. Through age-appropriate, interdisciplinary units, students develop foundational language skills that support cross-cultural communication and appreciation for linguistic diversity. Research indicates that early bilingual and multilingual education can strengthen executive functioning, cognitive flexibility, and problem-solving abilities in young learners, contributing to broader cognitive and academic development (Alabi, 2024; Barbu et al., 2024). Students also explore diverse cultures and perspectives to understand the value of inclusion, collaboration, and respect for cultural differences. Through inquiry-based and project-based learning experiences, learners investigate global challenges—including climate change, access to clean water, and social equality—through the framework of the SDGs. By emphasizing critical thinking, intercultural understanding, and ethical decision-making, Global Learners, Global Leaders prepares students to thrive in an interconnected world and contribute as informed, responsible global citizens.

Keywords: *Global competence, intercultural education, sustainable development, dual immersion, elementary education*

Introduction

In an increasingly interconnected world, education must extend beyond the acquisition of academic knowledge to include the development of skills necessary for navigating complex global systems. Students are required not only to understand content but also to engage with diverse perspectives, communicate across cultural boundaries, and contribute meaningfully to addressing global challenges. Global competence has therefore emerged as a critical educational priority. Global Learners, Global Leaders is an elementary-level framework designed to cultivate globally competent students through language learning, cultural exploration, and engagement with the United Nations Sustainable Development Goals (SDGs). As globalization increasingly shapes social, environmental, and economic systems, education must equip learners with the knowledge, skills, and dispositions necessary to understand diverse perspectives and address complex global challenges. Through interdisciplinary learning experiences, inquiry, and opportunities for action, students develop communication skills, intercultural understanding, critical thinking, and civic responsibility. The Organization for Economic Co-operation and Development (OECD, 2018) defines global competence as the capacity to examine issues of local and global significance, understand and appreciate multiple perspectives, engage in intercultural interactions, and to take action for collective well-being. The *Global Learners, Global Leaders* framework responds to this need by embedding global competence into elementary education through interdisciplinary, language-rich, and sustainability-focused instruction. Rather than treating global education as an isolated subject, this framework integrates it into daily teaching and learning, positioning students as future changemakers capable of contributing to a more just and interconnected world.

Theoretical Framework

The foundation of this work is grounded in global competence and education for sustainable development. The OECD (2018) framework identifies four core dimensions of global competence: investigating the world, recognizing perspectives, communicating ideas, and taking action. These dimensions align closely with Fernando Reimers' vision of education as a moral imperative, in which students are empowered to improve the world through knowledge, empathy, and purposeful action. In parallel, UNESCO (2017) emphasizes that education must equip learners with the knowledge, values, and skills necessary to achieve the Sustainable Development Goals (SDGs). The SDGs provide a meaningful framework for connecting classroom learning to real-world challenges, including climate change, inequality, and access to education. Additionally, research on bilingual and multilingual education underscores the cognitive benefits of early language learning. Studies demonstrate that students engaged in immersion programs exhibit enhanced executive functioning, cognitive flexibility, and problem-solving skills (Alabi, 2024; Barbu et al., 2024). These findings support the integration of language learning as a central component of global competence development. Together these foundations support an integrated model that develops knowledge, empathy, communication skills, and civic engagement.

Program Design and Implementation

The *Global Learners, Global Leaders* framework provides a comprehensive K–5 instructional model that integrates global competence into everyday teaching practices. It is guided by a vision of empowering learners to become curious, compassionate, and capable global leaders through language, inquiry, and purposeful action. This vision is supported by six guiding principles, including interconnectedness, multilingualism, critical thinking, collaboration, agency, and inclusive curriculum, which collectively ensure that global learning is embedded within core instructional practices rather than treated as an add-on. A key feature of the framework is its developmentally aligned structure, which organizes learning around grade-level themes connected to the Sustainable Development Goals. Younger learners begin by developing empathy and understanding of their immediate environment, while older students engage with more complex issues such as sustainability, equity, and global partnerships. This progression allows students to build knowledge and skills in ways that are both age-appropriate and increasingly sophisticated. Instruction within the framework is grounded in inquiry-based and project-based learning approaches. Students explore essential questions related to global issues, engage in perspective-taking, and collaborate with peers to develop solutions. Creative expression through art, storytelling, and multimedia further supports students in making connections between their learning and the world around them. The model is flexible enough to be implemented in dual language immersion programs, world language programs, and general education classrooms. Learning experiences may be delivered through interdisciplinary units, capstone projects, service-learning opportunities, and classroom investigations. Students explore topics such as environmental sustainability, cultural diversity, health and well-being, access to education, and community development. These themes provide meaningful opportunities to connect local experiences with global issues. Language learning is integrated throughout, enabling students to develop communication skills and an appreciation for linguistic diversity, which provides students the opportunity to strengthen their ability to communicate across cultures and engage with diverse communities.

Impact on Student Learning

The implementation of the *Global Learners, Global Leaders* framework supports multiple dimensions of student development. From a cognitive perspective, participation in bilingual and globally focused learning experiences enhances executive functioning, memory, and problem-solving abilities (Alabi, 2024; Barbu et al., 2024). Equally important are the social-emotional and intercultural outcomes. Students develop empathy and the ability to understand diverse perspectives through exposure to global cultures and issues. These experiences foster respect, inclusion, and a deeper appreciation for diversity. Engagement is also significantly enhanced when learning is connected to real-world challenges. Inquiry-based instruction encourages curiosity and student ownership, while project-based learning provides opportunities for meaningful application. As students explore SDG-aligned topics, they begin to see themselves as agents of change, developing a sense of civic responsibility and ethical awareness (UNESCO, 2017).

Assessment and Evidence of Learning

Assessment within this framework is designed to be authentic, reflective, and formative, emphasizing growth in global competence rather than solely content mastery. Students demonstrate their learning through a variety of modalities, including reflection journals, presentations, creative projects, and portfolios that document their evolving understanding of global issues. Evaluation criteria focus on students' ability to understand global challenges, consider multiple perspectives, collaborate effectively, communicate ideas, and take informed action. This approach aligns assessment practices with the broader goals of global competence and sustainability education, ensuring that students are evaluated on both knowledge and dispositions.

Discussion

The integration of global competence and sustainability education within elementary classrooms represents a significant shift in educational practice. Rather than positioning global education as an additional component, the *Global Learners, Global Leaders* framework embeds it within the core curriculum, making it accessible and relevant to all learners. This approach highlights the importance of early exposure to global learning. Elementary education provides a critical foundation for developing the knowledge, skills, and dispositions necessary for navigating a complex and interconnected world. By introducing global concepts at a young age, educators can foster long-term engagement and prepare students for future academic and professional success. Furthermore, the educational model demonstrates the importance of aligning curriculum, instruction, and assessment with global goals. It also underscores the need for professional development and collaboration among educators to support effective implementation. The framework also aligns with major educational priorities, including the OECD Global Competence Framework, the United Nations Sustainable Development Goals, ACTFL World-Readiness Standards, and the Virginia Profile of a Graduate. This alignment demonstrates that global learning is not an additional initiative but rather a powerful approach for achieving existing educational goals while preparing students for future success.

Conclusion

The *Global Learners, Global Leaders* framework illustrates the transformative potential of integrating global competence, language learning, and sustainability education in elementary settings. By providing students with opportunities to explore global issues, engage with diverse perspectives, and take meaningful action, this model prepares learners to thrive in an interconnected world. As global challenges continue to evolve, education systems must prioritize approaches that foster critical thinking, empathy, and collaboration. This framework offers a practical and scalable model for cultivating the next generation of global learners and leaders, ensuring that students are equipped not only to understand the world, but also to improve it.

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Enhancing Employability and Workplace Readiness through the International Career Coaching Programme (ICCP) in South African TVET Colleges

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Abstract

South Africa's TVET sector faces persistent challenges in preparing graduates with transferable skills for a volatile labour market. The International Career Coaching Programme (ICCP), developed through international collaboration and accredited by the UK CPD Certification Service, was designed to address this gap by embedding career coaching within vocational education. This study examines participant`s perceived outcomes of the ICCP in terms of employability, workplace readiness, and professional development among TVET students and lecturers. A mixed-methods approach was employed, combining pre- and post-programme questionnaires with thematic analysis of open-ended responses. Quantitative data were analysed using SPSS. Findings indicate broadly positive self-reported improvements in communication, problem-solving, teamwork, and workplace readiness, with entrepreneurial confidence emerging as a particularly salient perceived outcome. The programme's CPD-accredited international framing contributed to participant`s perceived global career awareness and professional legitimacy. Differential completion rates between students and lecturers are treated as analytically significant, reflecting structural inequalities in programme access rather than motivational deficiency. The study contributes to debates on career coaching in vocational education and argues that the ICCP provides a model for integrating structured coaching into TVET curricula, provided that implementation is accompanied by structural investment in digital access, workload accommodation, and institutional support.

Keywords: *TVET; employability; career coaching; workplace readiness; skills development; South Africa; CPD.*

1. Introduction

South Africa's TVET sector occupies a formally strategic position in national responses to unemployment, yet the gap between its policy mandate and its structural realities has proven difficult to close. With youth unemployment consistently above 50 per cent and the formal economy unable to absorb available labour at the scale required, the question of how vocational institutions prepare graduates for labour market entry carries social urgency beyond its educational dimensions [1,2]. TVET colleges are expected to produce technically capable, employment-ready graduates while simultaneously developing entrepreneurial capacity, digital fluency, and the transferable competencies that contemporary workplaces demand. The empirical record suggests they frequently fall short on all counts, not because of institutional failure alone but because of systemic under resourcing, curriculum misalignment, and a persistent mismatch between what colleges teach and what employers require [3,4]. Career coaching has attracted increasing attention as one intervention capable of bridging this gap. Unlike generic employability skills training, structured coaching is oriented towards developing goal clarity, professional self-efficacy, and the adaptability to navigate career transitions in contexts of uncertainty [5,6]. Evidence from higher education contexts suggests that coaching programmes can contribute meaningfully to students' employability competence development, particularly when they are sustained over time and incorporate reflection and goal-directed action [8,5]. Evidence from TVET specific contexts is considerably thinner, particularly in the African setting, where career guidance services remain underdeveloped and the structural barriers to graduate employment extend well beyond individual competence gaps [9,10,8].

The ICCP, developed through international collaboration and accredited by the UK CPD Certification Service, represents a structured attempt to integrate professional career coaching into the TVET environment. Delivered across multiple South African TVET colleges, the programme targets both

students and lecturers, aiming to develop employability competencies, entrepreneurial orientation, and workplace readiness while simultaneously building lecturer coaching capacity. Its international accreditation framework is a deliberate design feature, intended to confer professional legitimacy on participant credentials and to orient participants towards global as well as domestic career possibilities. This article examines participant`s perceived outcomes of the ICCP across the pre- and post-programme period, drawing on mixed-methods survey data from 160 pre-programme and 68 post-programme respondents. It does not make causal claims about programme effectiveness; the data are self-reported and cross-sectional, and are treated accordingly. The study's contribution is threefold, (1) it provides empirically grounded evidence on participant perceptions of career coaching in a South African TVET context, (2) it examines the role of international CPD accreditation in shaping participant-perceived professional legitimacy and career aspiration and, (3) it treats differential programme completion as a structural finding rather than a measurement inconvenience. The research questions are: (1) How did ICCP participants perceive the programme's contribution to their employability, workplace readiness, and professional development? (2) What role did the programme's international accreditation framing play in shaping participant perceptions of career possibility? (3) What do patterns of participation and completion reveal about the structural conditions for career coaching delivery in South African TVET colleges? By answering the research questions, the study aims to examine participant`s perceived outcomes of the ICCP in terms of employability, workplace readiness, and professional development among TVET students and lecturers. The next section will cover literature review.

2. Review of Related Literature

2.1 Theoretical Framework

A robust theoretical framework for this study draws on Human Capital Theory and Career Construction Theory to explain how structured career coaching interventions can strengthen employability and workplace readiness among students in South African TVET colleges. Human Capital Theory suggests that investment in knowledge, skills, and competencies enhances individual productivity and labour market competitiveness, positioning the ICCP as a mechanism for developing transferable skills such as communication, teamwork, adaptability, and entrepreneurial capacity [11]. Complementing this perspective, Career Construction Theory emphasises career adaptability, self-awareness, and proactive career planning as essential capabilities for navigating dynamic and uncertain labour markets [11]. Together, these theories provide a comprehensive lens for understanding the ICCP as an intervention that not only builds employability skills but also promotes career identity development and long-term professional readiness in an increasingly complex employment environment [12].

2.2 Employability and Workplace Readiness in TVET

Graduate employability in the South African TVET context is shaped by intersecting structural conditions: curriculum-industry misalignment, credential undervaluation relative to university qualifications, weak work-integrated learning infrastructure, and the socio-economic circumstances of the student population [3,13]. Research consistently identifies a gap between the competencies TVET graduates possess on completion and those that employers require, a gap that is simultaneously a curriculum problem, a pedagogy problem, and a structural labour market problem [4,14]. Soft skills, defined broadly as communication, teamwork, problem-solving, and adaptability, feature prominently in employer accounts of what TVET graduates lack, a finding with direct implications for programme design (15,16].

The concept of workplace readiness extends the employability frame: it refers to the combination of practical competence, professional orientation, and psychosocial preparedness that enables graduates to function effectively from the point of labour market entry [16,17]. Research on workplace readiness among South African TVET students identifies career self-efficacy, career exploration, and self-perceived employability as significant predictors, suggesting that affective and psychological dimensions of preparation matter alongside technical skill development [16]. Programmes that address these dimensions alongside hard skills may contribute to a more durable form of graduate readiness than those focused exclusively on technical competencies.

2.3 Career Coaching and Career Guidance in Vocational Education

Career coaching in educational contexts is characterised by a facilitative, goal-oriented process aimed at developing self-clarity, career goal clarity, and the confidence to act on professional aspirations [6,5]. According to [6] career resources model identifies self-clarity and career-goal clarity as foundational prerequisites for career optimism and career security, outcomes with direct relevance to TVET graduates navigating constrained opportunity structures. [5], in a multi-institutional study of career coaching in higher education in the Netherlands and Belgium, found that autonomy-supportive coaching was positively associated with employability competence development, with trial-and-error encouragement and reflective practice as key facilitative mechanisms.
In the African TVET context specifically, career guidance and counselling services are poorly developed, and the majority of graduates navigate career decision-making without structured institutional support [8,9]. According to [9] and [10] have documented the career barriers facing marginalised South African youth and the significance of contextually grounded interventions in supporting career adaptability among disadvantaged populations. [18] identifies self-knowledge and career exploration as foundational to sound career decision-making across international contexts, a framework that aligns with the ICCP's coaching design. The scarcity of structured career coaching provision in South African TVET colleges positions the ICCP as a rare institutional attempt to address this gap at scale.

2.4 CPD Accreditation, International Frameworks, and Professional Legitimacy

Professional accreditation in continuing professional development (CPD) serves multiple functions in vocational education: it provides quality assurance signals to participants, employers, and institutional partners; it confers credential recognition that individual college certificates may not command; and it positions programme participants within professional networks and discourses that extend beyond the national context [18,19]. For TVET participants in a context where vocational credentials are frequently undervalued relative to university qualifications, international CPD accreditation carries a specific legitimising function: it reframes the participant's learning within a credentialled professional identity that is recognised beyond the domestic South African system.

The aspiration to international career exposure and global professional participation is documented among TVET students in sub-Saharan African contexts as simultaneously rational, given domestic opportunity constraints, and aspirationally significant, in expanding the range of professional futures participants are willing to contemplate [10,20]. Programmes that explicitly engage this aspiration, by exposing participants to international professional standards, accredited credentials, and global network possibilities, may contribute to what has been described as a 'cosmopolitan capability': the professional orientation and confidence to engage with global as well as local career environments. Whether this translates into concrete mobility or international employment is a question beyond the reach of the present data; but the aspiration activation itself is analytically significant as an employability-relevant outcome.

2.5 Lecturer Professional Development and Coaching Capacity in TVET

TVET lecturer professional development is a documented weak point in the South African sector. [21] and [22] have documented the effects of professional competence deficiencies on lecturer confidence, self-efficacy, and institutional effectiveness, identifying inadequate training and development as a primary structural driver. Programmes that develop coaching capacity among lecturers carry implications beyond individual professional development: lecturers who acquire coaching skills and apply them in their institutional contexts function as multipliers, extending programme benefit to students and colleagues who did not participate directly [23]. This multiplier logic is central to the ICCP's institutional design, which targets lecturers alongside students in the expectation that lecturer development will generate downstream institutional benefit.

3. Research Methodology

3.1 Research Design

The study employs a cross-sectional mixed-methods design integrating both quantitative and qualitative approaches to provide a comprehensive understanding of participant experiences. Quantitative data

obtained from Likert-scale items in pre- and post-programme instruments are analysed descriptively using frequencies, means, standard deviations, and distributional comparisons, while qualitative responses from open-ended items are examined through thematic analysis using inductive coding procedures [24,25]. The two data streams are treated as complementary, where quantitative findings establish patterns and trends, and qualitative insights provide depth, context, and meaning. Given the exploratory nature of the study, no inferential statistical analyses are conducted, as the focus is on interpretation and participant perceptions rather than causal relationships or validated labour market outcomes.

3.2 Participants

Pre-programme data were collected from 160 participants across three TVET colleges: Majuba (n = 122; 76.3%), Vhembe (n = 30; 18.8%), and Central Johannesburg College (n = 5; 3.1%). The sample comprised 127 students (79.4%) and 33 lecturers (20.6%). The age distribution was weighted towards 25 to 34 years (43.9%), with substantial representation in the 18 to 24 bracket (33.1%). Most participants were affiliated with Business Studies programmes (65.6%), with the NCV and NATED levels near-equally represented. Post-programme data were returned by 68 participants (41 students; 27 lecturers), representing 42.5 per cent of the pre-programme cohort. Lecturer completion was approximately 81.8 per cent of the pre-programme lecturer group; student completion was approximately 32.3 per cent. This differential is treated analytically as a structural feature of the programme's interaction with participants' different institutional and socio-economic circumstances, and conditions all post-programme findings reported below.

Table 1. provides a summary profiles

Table 1: Participants profiles summary

Variable	Category	Pre-programme (N=160)	Post-programme (N=68)
Role	Student	127 (79.4%)	41 (60.3%)
	Lecturer	33 (20.6%)	27 (39.7%)
College	Majuba	122 (76.3%)	34 (50.7%)
	Vhembe	30 (18.8%)	23 (34.3%)
	CJC / Other	8 (5.0%)	11 (16.2%)
Programme Level	NCV	75 (46.9%)	21 (30.9%)
	NATED	78 (48.8%)	41 (60.3%)
Field	Business Studies	105 (65.6%)	55 (84.6%)
	Engineering / Other	55 (34.4%)	13 (19.1%)

Source: Authors own compilation

3.3 Instruments and Analytic Procedure

The pre-programme instrument addressed participant demographics, self-assessed confidence across five employability competency domains on a five-point Likert scale (1 = Not Confident; 5 = Very Confident), and open-ended items on career goals, motivations, and expected programme benefits. The post-programme instrument addressed overall programme experience, content relevance, satisfaction with delivery, self-reported improvement across the same five domains (1 = No improvement; 5 = Significant improvement), and open-ended items on career aspiration change, skills application, entrepreneurial orientation, institutional value, and challenges. Qualitative responses were coded inductively, with thematic categories reviewed through the conceptual lenses described in the literature review.

3.4 Limitations

The study is subject to four substantive constraints. First, all data are self-reported; perceived improvement cannot be equated with verified skill development or labour market outcome. Second, the substantial attrition between pre- and post-programme samples introduces completion bias: findings from the post-programme instrument represent participants who completed the programme and are not representative of the full initial cohort. Third, the unmatched design of the pre- and post-programme samples precludes direct individual-level comparison. Fourth, the open-ended framing of some items, particularly on institutional benefits, may have primed responses using programme language. These limitations are acknowledged throughout and condition the scope of all claims made.

4. Results

4.1 Baseline Competency Confidence and Career Orientation

Pre-programme Likert responses indicated high overall confidence, with notable variation across domains. Teamwork and collaboration returned the highest mean (M = 4.74, SD = 0.53), followed by workplace readiness (M = 4.58, SD = 0.74), communication skills (M = 4.54, SD = 0.65), and problem-solving (M = 4.45, SD = 0.68). Entrepreneurial skill was the exception: lower mean (M = 4.17), wider standard deviation (SD = 0.93), and modal and median values of 4 rather than 5. Table 2 presents the full profile. Perceived job market readiness was similarly high overall (M = 4.44, SD = 0.83), though approximately one in three respondents rated themselves at level 4 rather than the highest level, indicating that confident but not fully settled self-assessment was common. Table 2. Provides a baseline self-assessed competency confidence (pre-programme; scale 1–5).

Table 2. Baseline Competence full profile

Competency Domain	Valid (n)	Mean	Median	SD
Communication skills	142	4.54	5.0	0.65
Problem-solving skills	140	4.45	5.0	0.68
Teamwork and collaboration	151	4.74	5.0	0.53
Entrepreneurial skills	135	4.17	4.0	0.93
Workplace readiness	142	4.58	5.0	0.74

Source: Authors own compilation

Pre-programme open-ended responses revealed differentiated aspirational orientations across the two participant groups. Student career goals centred on labour market entry, further qualification, and entrepreneurial aspiration, with a recurrent motif of international career exposure: multiple students described aspirations to work overseas or access globally recognised credentials. Lecturer goals were oriented around pedagogical leadership, curriculum innovation, and institutional contribution. These divergent orientations at baseline are analytically significant: they establish that students and lecturers entered the programme with structurally different frames of reference, a differentiation that shapes how post-programme perceptions should be read.

4.2 Post-Programme Experience and Self-Reported Skill Development

Post-programme ratings were strongly positive. Overall experience had a mean of 4.53 (SD = 0.70), with 64.7 per cent at the highest level and no respondent below 3. Content relevance to career goals returned a mean of 4.49 (SD = 0.74). Satisfaction with trainers and coaches was highest (M = 4.59, SD = 0.74), with accessibility also highly rated (M = 4.47, SD = 0.80). Programme materials were comparatively lower (M = 4.29 to 4.31), suggesting a relative gap in resource quality relative to human delivery quality. Self-reported improvement across competency domains was broadly high, as shown in Table 3. Communication skills returned the highest improvement mean (M = 4.58, SD = 0.63), with problem-solving (M = 4.49), workplace readiness (M = 4.40), entrepreneurial skills (M = 4.35), and teamwork (M = 4.32) following. Across all domains, no respondent reported no improvement; minimum

reported improvement was level 2 for teamwork and level 3 for all others. **Table 3** below presents self-reported competency improvement following ICCP participation (post-programme; scale 1–5).

Table 3. Post-program competency

Competency Domain	Valid (n)	Mean	SD	% at 4 or 5
Communication skills	67	4.58	0.63	92.5
Problem-solving skills	68	4.49	0.68	89.7
Teamwork and collaboration	68	4.32	0.84	82.4
Entrepreneurial skills	68	4.35	0.82	84.0
Workplace readiness	68	4.40	0.76	83.8

Source: Authors own compilation

The entrepreneurial skills domain warrants attention: the post-programme improvement means (M = 4.35) exceeded the pre-programme confidence baseline for the same domain (M = 4.17), and the standard deviation narrowed (from 0.93 to 0.82). This pattern suggests that participants who reported lower confidence at baseline described comparatively larger perceived gains in this domain. The pre- and post-programme samples are not matched, and the shift may partly reflect selection; what can be said is that entrepreneurial confidence was the domain where the distributional contrast between baseline and post-programme self-assessment was most pronounced.

4.3 Employability, Workplace Readiness, and Global Career Orientation

Qualitative post-programme responses on employability and workplace readiness centred on three patterns: perceived gains in professional communication and self-presentation; an enhanced capacity to engage with formal workplace norms; and a perceived broadening of career horizon from local to international. Students described the programme as having addressed a gap between their college learning and workplace competency expectations, a gap consistent with documented curriculum-industry misalignment in the South African TVET sector [3,4]. Multiple participants described reorienting their job search frame to include global possibilities, with accounts of advising fellow students not to limit themselves to the South African market.

The international accreditation dimension of the programme appeared to contribute to this reorientation. Several participants described the UK CPD Certification Service accreditation as having conferred a form of professional legitimacy that distinguished their participation from ordinary college activity. One participant described the certificate as evidence that their training met an internationally recognised standard, while another described using the accreditation to position themselves in job applications beyond South Africa. These accounts suggest that the programme's international framing contributed to participant-perceived credential value and global career orientation, consistent with the aspirational function of international accreditation described in the literature.

4.4 Perceived Entrepreneurial Confidence and Orientation

Entrepreneurial orientation was among the most generative themes in the post-programme qualitative data. Two patterns were present. The first, which might be called perceived confidence activation, involved accounts of a shift in participants' willingness to contemplate entrepreneurial activity: descriptions of no longer feeling that entrepreneurship was inaccessible, of becoming aware of available funding ecosystems, and of beginning to take initial steps, including forming teams, conducting sector research, and applying for grants. The second pattern involved accounts of concrete initial activity: participants described having started a small business or side venture during or immediately following the programme. Both patterns should be read carefully. The data support claims about perceived entrepreneurial orientation and reported initial steps, not about verified venture creation or sustained entrepreneurial activity. In the South African context, structural barriers to entrepreneurship, including limited access to finance, weak business support infrastructure, and constrained market access, are well documented and are not resolved by a coaching intervention alone [9,16]. The significance of the entrepreneurial confidence finding lies in the perceived orientation shift: participants reported a changed

sense of possibility rather than a guaranteed business outcome, which is a meaningful intermediate outcome in itself.

4.5 Career Coaching Outcome Pathway in the ICCP

Figure 1 presents a synthesising model of the perceived outcome pathway in the ICCP, organising the empirical findings from Sections 4.2 to 4.4. The model foregrounds the differentiated nature of outcomes across student and lecturer groups and notes the participation-conditional character of the pathway: structural barriers shape who reaches each stage of the outcome sequence. Figure 1. Below present the participant`s perceived career coaching outcome pathway in the ICCP (based on pre- and post-programme survey data).

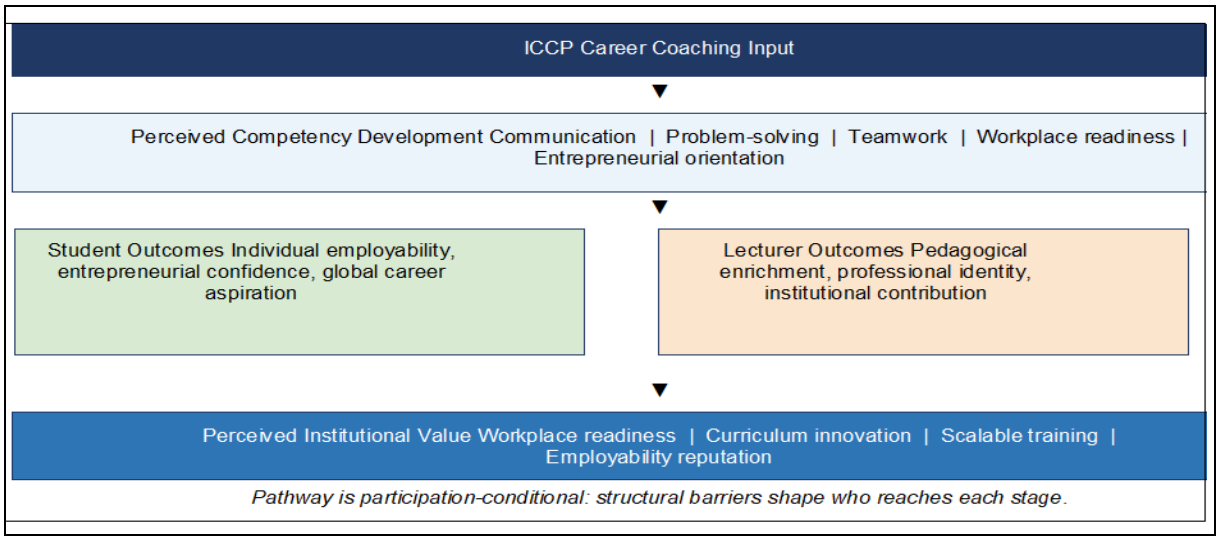


Fig. 1. ICCP Career Coaching Pathway
Source: Authors own compilation

4.6 Differential Patterns: Students and Lecturers

As documented in the companion articles in this series, students and lecturers engaged with the programme from structurally different positions and attributed different forms of value to their participation. Students oriented perceived benefit around personal employability, entrepreneurial aspiration, and global career possibility. Lecturers framed benefit through professional identity, pedagogical enrichment, and institutional contribution, with multiple accounts of sharing programme learning with students and colleagues.

4.7 Implementation Challenges and the Attrition Finding

Post-programme open-ended responses identified a consistent cluster of implementation barriers: workload and time pressure, digital connectivity constraints, platform navigation difficulties (particularly regarding LinkedIn), and variable mentorship quality. These findings are documented in detail in Article 2 of this series. For the purposes of the present analysis, the critical finding is the differential completion rate: approximately 81.8 per cent of pre-programme lecturers completed the post-programme evaluation, compared with approximately 32.3 per cent of students. This differential is not incidental; it reflects the structural incompatibility between the programme's demands and the time, resource, and digital access circumstances of TVET students under South African conditions. The post-programme findings described above should therefore be understood as representing the experience of programme completers: disproportionately lecturers, and among students, those for whom structural barriers were insufficiently severe to prevent completion. [25] have documented the multidimensional causes of student attrition in South African TVET colleges; the attrition pattern in the ICCP data is consistent with those causes and should be read structurally rather than individually.

5. Discussion

The findings suggest that the ICCP positively influenced employability, workplace readiness, and career development among programme completers by strengthening competencies frequently identified in TVET literature as important for graduate preparedness, including professional communication, career adaptability, self-efficacy, and career aspirations. Entrepreneurial confidence emerged as a particularly important outcome, indicating improved perceptions of participants' ability to identify opportunities and pursue diverse career pathways. The programme's mentored coaching structure appears to have supported this development by enhancing confidence, facilitating career goal formation, and encouraging entrepreneurial thinking beyond immediate employment outcomes. International CPD accreditation also emerged as a significant programme component, with participants perceiving accredited certification as enhancing the legitimacy and credibility of their qualifications while strengthening their professional identity and confidence regarding broader career opportunities. However, high levels of participant attrition highlighted structural challenges such as limited digital access, workload pressures, and competing responsibilities, suggesting that programme effectiveness may be influenced by contextual factors beyond the intervention itself. These findings indicate that while the ICCP demonstrates potential as a scalable career development intervention within TVET education, stronger institutional support, resource provision, and inclusive implementation strategies are necessary to improve participation and sustained engagement.

6. Recommendations for Policy and Institutional Practice

The findings of this study suggest several implications for policy and institutional practice within the South African TVET sector. First, career coaching interventions such as the ICCP should be integrated more systematically into TVET curricula rather than implemented as stand-alone extracurricular initiatives. Embedding structured coaching within existing academic programmes may improve accessibility, participation, and long-term sustainability. Second, institutions should strengthen digital support systems to address barriers related to connectivity, platform access, and digital literacy. The high level of student attrition observed in this study indicates that unequal access to technological resources continues to shape participation outcomes within coaching and professional development programmes. Third, workload-sensitive programme design is necessary, particularly for students balancing academic, financial, and personal responsibilities. Flexible scheduling, blended learning approaches, and extended completion timelines may improve programme retention and participation equity. Fourth, TVET colleges should invest in lecturer coaching capacity development, as lecturers who acquire coaching and mentoring competencies may serve as institutional multipliers by extending employability support to wider student populations. Finally, future programme implementation should incorporate longitudinal graduate tracking systems to evaluate long-term employability outcomes, entrepreneurial activity, and workplace integration beyond self-reported participant perceptions. Such evidence would strengthen the empirical basis for scaling career coaching interventions across the TVET sector.

7. Conclusion

This study examined participants perceived outcomes of the ICCP within South African TVET colleges, focusing on employability, workplace readiness, entrepreneurial confidence, and the role of international CPD accreditation in shaping professional identity and career aspirations. The findings revealed positive self-reported development across key competency areas among programme completers, with entrepreneurial confidence demonstrating the most substantial improvement. The accreditation component further contributed to perceptions of enhanced professional legitimacy and increased confidence regarding broader career opportunities. The study contributes to the TVET employability and career coaching literature by providing evidence of participant experiences within an internationally accredited intervention in the South African context and by highlighting that programme completion patterns may reflect structural and contextual barriers rather than individual limitations. Future research should adopt longitudinal approaches to assess the sustainability of programme outcomes and explore barriers experienced by non-completers to strengthen understanding of long-term impacts and support more equitable participation in similar initiatives.

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Whose Design Knowledge? Adapting the Culturally Responsive Curriculum Scorecard for Graphic Design Higher Education

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Abstract

Despite increasing calls to decolonise design education, most curricula have not been systematically examined. Formal curriculum documents, such as assessment briefs, lecture slides, visual references and prescribed readings, carry cultural assumptions about which designers matter, which design histories are legitimate and which design aesthetics are valued. This article makes these patterns visible by using the Culturally Responsive Curriculum Score Card (CRCS), a tool that was originally developed for high-school English language curricula. The CRCS was adapted to fit within Graphic Design higher education and was applied to a graphic design unit of study in Australia. Syllabus documents, design briefs, assessment rubrics, workshops, prescribed readings and seminar slides were examined across the scorecard's three domains: Representation, Social Justice Orientation and Teacher's Materials. The unit scored both Culturally Insufficient for Representation and Social Justice, and Emerging Awareness for Teacher's Materials. The analysis made 5 structural patterns visible: geographic concentration of exemplars, monolingual typographic normativity, assessment criteria rooted in unmarked cultural norms, cultural content present but unframed, and assumed rather than designed inclusivity. These patterns highlight how dominance is reproduced through omission rather than deliberate exclusion. The adapted CRCS can be transferred to other practice-based disciplines where canonical knowledge operates through visual and material systems.

Keywords: *culturally responsive teaching, graphic design education, curriculum analysis, scorecard, representation, higher education*

1. Introduction

Australian higher education classrooms are characterised by their cultural and linguistic diversity. Recent data shows that approximately a third (30.7%) of Australians were born overseas (Australian Bureau of Statistics 2023), and international student enrolments exceeded 840,000 (Department of Education 2024). Additionally, over 300 ethnic groups are represented, and about 21% of the population speaks a language other than English at home (Australian Bureau of Statistics 2023). Many of these students bring design knowledge shaped by non-European histories, non-Latin typographic traditions and diverse aesthetic conventions to the graphic design classroom. This trend is not only observable in Australia but is a global phenomenon. Similar demographic shifts are also occurring in other OECD countries (OECD 2025). However, the recruitment of culturally diverse students has often served as an internationalisation strategy, with the curriculum itself not being adapted or examined accordingly (Brewer and Leask 2012).

Graphic design education has been predominantly shaped by Bauhaus-derived pedagogical frameworks rooted in European design traditions (Holmes Miller 2023; Noel et al. 2023), operating within what Noel et al. (2023) consider a hegemonic frame of reference. This is consistent with further criticisms of the internationalisation of the curriculum, which point to the dominance of Western perspectives in the structuring and teaching of knowledge in higher education (Brewer and Leask 2012). This results in a discrepancy between who is in the classroom and what the curriculum recognises as valid knowledge (Apple 2012). Students whose design traditions, language, and visual systems are not acknowledged within the curriculum receive an implicit message that their expertise falls outside the disciplinary norm. This exclusion is often implicit rather than explicit, created through omission (Giroux 2020).

There is an increasing call within design scholarship for the decolonisation of design curricula (Abdulla, 2019; Tunstall, 2023; Holmes Miller, 2023; Pater, 2021). However, these discussions have mainly focused on teaching practice and/or pedagogical intent (Davis 2017; McCoy 2022). A more systematic analysis of the curriculum documents and artefacts, such as syllabi, briefs, seminar materials, reading lists and assessment rubrics, has received less attention (Sales 2023; Noel et al. 2023). These documents determine what content students encounter and what knowledge is legitimised before

teaching takes place (Apple 2012; Darder 2012). The curriculum, thus, carries an implicit message of which designers matter, which histories are legitimate and which visual traditions are foregrounded. When these structures are not being questioned, even a well-intentioned curriculum can reproduce dominance through omission.
Bryan-Gooden, Hester and Peoples (2019) developed a systematic approach, the Culturally Responsive Curriculum Scorecard (CRCS), to make these embedded messages visible. This tool was originally developed for the K–9 English Language Arts curriculum. This article reports on an application of the adapted CRCS to one unit of study at one Australian institution. It presents findings across three domains, identifies five structural patterns as diagnostic indicators for curriculum review, and examines the implications of these patterns for student belonging and for curriculum design practice.

2. Theoretical Framing

The study draws on Culturally Responsive Teaching and Critical Pedagogy as an analytical lens to examine how knowledge is constructed, legitimised and reproduced within the education setting. Apple (2012) argues that curriculum decisions are not technical but ideological in nature and reflect social and political interests which determine whose knowledge is selected, valued and taught. Giroux (2020) expands this with the concept of the hidden curriculum, which describes how educational institutions implicitly convey values, norms and assumptions through what knowledge is included and what is omitted. These omissions are not accidental but function as a power mechanism that privileges certain traditions and renders others invisible.
Darder (2012) claims that the curriculum is a site of cultural reproduction where dominant ideologies are transmitted through materials, structures and pedagogical assumptions. This perspective is supported by hooks (1994), who argues that education can operate as a site of dominance, particularly when one cultural perspective is placed at the centre as universal, it silences marginalised communities.
Culturally responsive teaching (Gay 2018) offers a pedagogical response to these structural conditions. Gay (2018) argues that teaching becomes culturally responsive when it acknowledges the cultural knowledge that students bring with them and incorporates it into curriculum content, teaching practice, and assessment. Ladson-Billings (1995) also understands cultural relevance as a pedagogical principle that places students' experiences at the centre rather than treating them as secondary.
When curriculum structures exclude students' cultural knowledge, the effects extend beyond content learning. Walton and Cohen (2007) argue that students of socially stigmatised groups experience *belonging uncertainty* in academic contexts: uncertainty about the quality of their social bonds and heightened sensitivity to issues of social belonging. Gopalan and Brady (2020) confirm that minoritised students report lower belonging, which predicts persistence, engagement and mental health.
Understanding how curriculum documents create these conditions requires a systematic examination of what they include and exclude. The Culturally Responsive Curriculum Scorecard (Bryan-Gooden, Hester, and Peoples 2019) provides a method for making visible what Apple (2012) describes as ideological curriculum decisions and what Giroux (2020) identifies as the hidden curriculum. Developed within a CRT framework, the CRCS interrogates the extent to which these documents reflect or exclude diverse perspectives. This study adapts this instrument for higher education in graphic design, applying it to curriculum documents that have not previously been subjected to such analysis.

3. Method

This study uses document analysis as its primary qualitative method. Bowen (2009) describes document analysis as an iterative process that combines elements of content and thematic analysis and involves skimming, in-depth reading, and interpreting institutional documents. Documents are not to be treated as complete records of facts but rather interrogated in terms of their meaning and contribution to the research questions (Bowen 2009). In this study, curriculum documents, including syllabi, design briefs, seminar materials, and required reading, are treated as artifacts that convey institutional values and disciplinary norms even before teaching takes place. The analytical tool applied to these documents is the CRCS (Bryan-Gooden, Hester, and Peoples 2019), which examines the curriculum in three key areas: representation, social justice, and teacher's materials. Since the tool was developed for an English Language Curriculum, the original statements focused on narrative, texts, character portrayals, and primary/secondary literature context, which required an adaptation to fit within graphic design higher education.
Each statement was examined for its transferability across the three domains. Within Representation, character-based language was replaced with designers, case studies, typographic systems, and cultural

frames of reference. In the area of Social justice, the statements were adapted to determine whether the curriculum situates design as embedded within power structure, whether multiple cultural frames of reference are recognised as equally valid, and whether design practice is linked to real-world social contexts. Statements within Teacher's Materials were shifted from teachers in school settings and literacy-related curricula to design educators and studio-based teaching materials.
In this study, the researcher examined whether the documents provided guidance for teachers on cultural positioning, bias in critique, and the recognition of students' prior cultural knowledge. Items were classified as non-transferable if their content was specifically geared toward narrative fiction or character-based literacy instruction and lacked a functional equivalent in studio-based design education. Items were classified as transferable if the underlying principle (e.g. whether diverse knowledge systems are positioned as equivalent) could be meaningfully assessed within curriculum documents in graphic design, even if the specific wording required adaptation (Table 1). Statements that were determined redundant or not transferrable were removed. Those that remained applicable were retained unchanged.

Table 1. Examples of adaptation

Adapted	Adapted statement	Original source items	Adaptation rationale
RE1	Case studies and examples used in class draw from culturally and geographically diverse contexts, and avoid homogenising or ambiguous representations.	1. The curriculum features visually diverse characters, and the characters of color do not all look alike. / 3. Diverse ethnicities and nationalities are portrayed – not all Asian families are Chinese, not all Latinx families are Mexican, etc. / 13. Diverse characters are rooted in their own cultures and are not ambiguous.	Reframed from fictional characters to design case studies and exemplars. The concern with characters not all looking alike (item 1) and diverse nationalities (item 3) became a requirement for geographic and cultural diversity in design examples. The anti-ambiguity requirement from item 13 was retained directly.
SJ6	The curriculum encourages students to design strategies that are inclusive of diverse cultural perspectives and lived experiences.	19. The curriculum presents different points of view on the same event or experience, especially points of view from marginalized people/communities.	Reframed from presenting multiple perspectives on events to designing inclusive strategies. The design-specific application replaces the narrative framing.
TM1	Teaching materials and curricular artefacts reflect contributions from staff of diverse identities, acknowledging how representation in authorship shapes classroom culture.	22. The authors of the teachers' materials are people of diverse identities (race/ethnicity, gender, other identities if possible).	Retained and expanded. "Authors" became "staff" to reflect the higher education context. The clause about representation shaping classroom culture makes explicit a concern implicit in the original.

Each item was examined through two rounds of scoring using the scorecard's rubric bands, with a written justification for each score. The CRCS uses a four-point scoring system ranging from +2 (Very Satisfied: clear evidence of intentional CRT design) through +1 (Satisfied: some CRT elements present) and –1 (Unclear: minimal or ambiguous evidence) to –2 (Not Satisfied: little or no consideration of CRT principles). Scores were then aggregated across items for each domain to generate domain-level scores. When an item was ambiguous during scoring, the decision was based on whether the curriculum document contained explicit, structural evidence rather than whether it could theoretically be met through individual teaching practice. This was a necessary distinction, since the scorecard captures what the curriculum conveys as a written artifact, not what might occur in classroom practice. It should also be noted that the researcher is a lecturer of the unit under investigation, which allowed for detailed familiarity with the curriculum materials and their application context; however, it also carries the risk of normalising existing structures. To counteract this, the scoring was solely based on the rubric criteria and not the researcher's own teaching experience or intent. All justifications were documented to allow for external review.

4. Findings

The examined curriculum scored in the following ranges:

Table 2. Scores across the three domains of the adapted CRCS.

Domain	Score / Classification
Representation	–6 / Culturally Insufficient
Social Justice	–7 / Culturally Insufficient
Teacher Materials	+1 / Emerging Awareness

Representation and Social Justice both scored within the Culturally Insufficient range, which indicates limited structural alignment with culturally responsive teaching principles. The Teaching Materials domain, in contrast, achieved a score within the Emerging Awareness range. Place-based tasks and flexible design outcomes provided a certain foundation; however, there was limited guidance on positioning, cultural differences, critical analysis and teacher positionality. Beyond the numerical scores, the curriculum analysis generated five structural patterns that appeared across all three domains. The following patterns are not only presented as case-specific findings but also as diagnostic indicators that curriculum designers and program coordinators in practice-based disciplines can use to examine their own curriculum documents.

4.1 Pattern 1: Geographic Concentration of Exemplars

Diagnostic question: *Do the case studies, visual references, and historical content in your curriculum draw from more than one geographic and cultural tradition?*
The curriculum under investigation drew heavily on examples from European, North American and Australian designers, with a recurring focus on modernism, Bauhaus and Swiss International Style principles. The analysis revealed a focus on culturally dominant design references, with a scarcity of representation of Indigenous, migrant, queer or working-class communities. Instead, target audiences were mainly framed as English-speaking, urban and middle-class. Designers of colour, women, and gender-diverse designers were almost entirely absent from core teaching materials and only appeared sporadically in supplementary resources. Designers from Africa, South America, South Asia, East Asia and Indigenous cultures were not represented. The dominance of canonical white male designers reduced students' opportunities to encounter other design perspectives that align with their own identities or cultural backgrounds. Historical content followed a Euro-American trajectory and neglected alternative design histories and Indigenous or diasporic traditions. This geographical narrowing was not only evident within Representation but also within Social Justice, where non-dominant populations were not represented through a strengths-based perspective, and opportunities to make cultural expertise or community-specific knowledge visible were minimal. Where a curriculum draws its exemplars predominantly from a singular geographical perspective or cultural cluster, it becomes the primary frame of reference for design learning regardless of the diversity of its student cohort.

4.2 Pattern 2: Monolingual Typographic Normativity

Diagnostic question: *Does your curriculum engage with non-Latin scripts and multilingual design practice as structured content, or only incidentally?*
Visual reference in seminar slides and case studies predominantly focused on modernist and minimalist typographic traditions in English and Latin scripts. Non-Latin writing systems such as Arabic, Devanagari, Hangul or Kanji were only mentioned in passing, without any structural introduction to multi-lingual or culturally specific typographic systems. Therefore, bi-scriptural design practices were not addressed. This pattern was visible across all three CRSC domains. There was no guidance for teachers or students on how to address and work with non-dominant typographic systems. Indigenous language systems were completely absent from the curriculum. Given that students bring multilingual competencies and knowledge of diverse typographic traditions, the exclusive focus on Latin typography conveyed a normative stance on which languages are recognised as a valid source of design knowledge.

4.3 Pattern 3: Assessment Criteria Rooted in Unmarked Cultural Norms

Diagnostic question: *Do your assessment criteria and evaluative language name the cultural and aesthetic tradition they derive from?*
Assessment rubrics and criteria defined quality through terms such as "professional", "polished", or "grid-aligned" without addressing that these terms reflect a specific cultural tradition. These design criteria and norms, which are based within a culturally dominant framework, function as an unmarked quality standard. Thereby, student work that uses a culturally dominant or culturally diverse design tradition is measured against a single tradition. This is exacerbated by a lack of guidance for teachers on addressing their own bias and assumptions in assessments and critiques, or on questioning whose quality standards are applied and whose are denied. This leads to critique protocols based on "professional standards" that fail to consider how dominant aesthetics disadvantage underrepresented students who design outside the dominant cultural norm. Without naming the cultural origin of evaluative language, students from other aesthetic traditions encounter criteria that appear neutral but have a normative effect.

4.4 Pattern 4: Cultural Content Present but Unframed

Diagnostic question: *Where cultural engagement opportunities exist, are they explicitly framed as cultural content and linked to learning outcomes?*
Whereas the curriculum allowed for cultural engagement and expression there was no framing or guidance on what cultural frameworks were being engaged. Several assignments allowed students to draw on their own cultural backgrounds and choose target audiences and contexts that align with their own cultural backgrounds. However, this was not linked to formal learning outcomes and was not reinforced through prompts, analytical tools, or examples. This meant the potential for cultural integration relied on students' own initiative rather than being supported by formal curricular documents that could have helped to link cultural meaning to design decisions. Individual reading activities, such as a reading on design ethics, encouraged reflection on industry norms. However, these instances were not woven throughout the course materials and remained isolated learning experiences. This pattern continued into the teaching materials, where isolated prompts invited reflections on personal experiences but were not embedded more systematically. Without explicit frameworks, culturally relevant content cannot be systematically developed, and student learning cannot be assessed or linked to outcomes. Identifying cultural content as such is a prerequisite for pedagogical effectiveness.

4.5 Pattern 5: Assumed Rather than Designed Inclusivity

Diagnostic question: *Does your curriculum explicitly design conditions for cultural responsiveness, or does it assume that task flexibility will produce inclusive outcomes?*
The curriculum design supported place-based learning and task flexibility. Some assessment tasks were linked to local contexts with flexible deliverables. These options were outlined within the assessment structure; however, it was not addressed how culturally specific methods could be integrated within assessment tasks, nor how they could be recognised as a formal outcome. The analysed unit of study did not provide any guidance for teachers on how to address cultural sensitivity or reflect on cultural assumptions. Culturally responsive teaching was possible within the curriculum structure but required teachers to enact these principles independently, as the written curriculum did not consistently provide the necessary conditions. Therefore, responsiveness functioned as an individual responsibility, not as an institutional design decision.

5. Implications for Teaching and Student Learning

The five patterns identified in this study are not attributed to individual bias. Instead, they are embedded in curricular documents, which exist independently of individual teaching decisions. The scorecard made these conditions visible, not because they are hidden, but because they are default assumptions within the curriculum as a designed artifact.

5.1 Implications for Students

The scores for Representation (–6) and Social Justice (–7), both classified as Culturally Insufficient, indicate that the curriculum does not create conditions for what Gay (2018) defines as culturally

responsive teaching: teaching that acknowledges the cultural knowledge students bring and incorporates it into curriculum content, practice and assessment. When the curriculum excludes students' cultural knowledge (Gay 2018), it signals whose knowledge is valid within the discipline. Walton and Cohen (2007) argue that students from minority groups perceive such exclusion as uncertainty about their place, questioning whether "people like me belong here" (p. 83). Gopalan and Brady (2020) empirically confirm that underrepresented minority and first-generation students at four-year institutions report a lower sense of belonging. In graphic design education, such signals of belonging are enacted through studio-based critique, visual references and assessment criteria, even before teaching takes place.

Geographic concentration of exemplars (Pattern 1) and monolingual typographic normativity (Pattern 2) signal whose design traditions are treated as disciplinary knowledge. Assessment criteria rooted in unmarked cultural norms (Pattern 3) position students working from non-Eurocentric visual traditions against a standard that does not name the tradition from which it originates. Their work is not read as an alternative approach but rather measured as deficient. Where cultural content exists but is unframed and unlinked to learning outcomes (Pattern 4), students from non-dominant traditions must do additional, unrecognised work to locate themselves within the curriculum. Thomas and Quinlan (2023) demonstrate that minoritised students in higher education perceive their curriculum as less culturally sensitive than their majority peers, and this perception accounts for lower teacher interactions and interest. Kahu and Nelson (2018) identify belonging as one of four psychosocial mechanisms that mediate student engagement. If belonging is undermined by the curriculum itself, the effects extend to self-efficacy and academic outcomes.

In a multicultural country like Australia, not only international but also local students bring diverse design knowledge from non-European histories and non-Latin typographic traditions to the classroom. Universities recruit this diversity as part of their internationalisation strategy (Brewer and Leask 2012). They then place these students in a curriculum consisting of teaching artifacts that do not acknowledge the design traditions and knowledge that diversity represents. Prior research has identified the tension between pedagogical intent and teaching practices (Abdulla 2019; Tunstall 2023; Noel et al. 2023); however, the contribution of this study lies in the empirical evidence for how this tension is embedded in curriculum documents themselves. The results of the scorecard demonstrate that the signals students receive are not necessarily produced by individual teaching decisions but are embedded within the curriculum itself.

5.2 Implications for Curriculum Design and Delivery

Each pattern identifies a condition that constrains teaching practice and requires action at the level of curriculum design and institutional resource allocation. Design educators typically enter teaching from professional practice rather than through formal pedagogical training (Davis 2017; Cezzar 2020). The written curriculum, therefore, functions as their primary pedagogical framework. When that framework has not been examined for its cultural positioning, the teacher inherits its assumptions.

Pattern 5 (assumed rather than designed inclusivity) directly frames this limitation. The Teacher's Materials domain scored +1 (Emerging Awareness), indicating that while some structural foundations existed, the curriculum offered no guidance on cultural positioning, bias in critique, or recognition of students' prior cultural knowledge. Culturally responsive teaching was possible within the curricular structure but was not systematically supported. This could lead to inconsistency across a teaching team and make students' access to culturally responsive teaching contingent on which instructor they are assigned to.

The remaining patterns specify what structural support would be needed. Geographic concentration of exemplars (Pattern 1) requires investment in sourcing and curating materials from a broader range of traditions. Furthermore, attention must be paid to the composition of curriculum development teams, as a culturally homogeneous team tends to reproduce the same frame of reference. Monolingual typographic normativity (Pattern 2) requires expertise in non-Latin typographic systems, which may not exist within the current teaching team. This necessitates either staffing investment or targeted professional development. Assessment criteria rooted in unmarked norms (Pattern 3) require programme-wide revision of rubrics and learning outcomes. Such a change cannot be made unilaterally by an individual teacher.

Unframed cultural content (Pattern 4) requires curriculum documents to identify cultural material as such and connect it to learning outcomes. The CRCS provides a systematic evaluation of existing curriculum documents, while Thomas and Quinlan (2024) developed an educator self-reflection tool that supports individual educators in recognising and addressing cultural assumptions in their own teaching materials.

Used in conjunction, these instruments could support curriculum review at both programmatic and individual levels. However, their effectiveness depends on institutional commitment to embedding them in curriculum review processes.

These conditions cannot be addressed through a single revision. Leask (2015) argues that internationalisation of the curriculum requires sustained institutional commitment, disciplinary expertise, and continuous engagement with changing contexts. Marantz-Gal and Leask (2020) reinforce this, arguing that constant shifts in institutional and disciplinary contexts mean that regular review and reconstitution of the curriculum should be a priority. However, such commitment presupposes empirical documentation of the structural conditions embedded in curriculum documents themselves. Existing calls for the decolonisation of design curricula have focused on what should change (Abdulla 2019; Tunstall 2023; Holmes Miller 2023). This study contributes a documented account of what specific structural conditions need to change, at what level, and with what resource implications. The five patterns, derived from a systematic analysis of curriculum documents rather than from pedagogical intent, provide an empirical basis for curriculum review in graphic design and potentially in other practice-based disciplines where disciplinary norms are transmitted through canonical examples, material traditions and studio-based assessment.

The adapted CRCS makes the question “Whose design knowledge?” empirically answerable. While existing calls for decolonisation identify what should change, this study documents what currently exists in curriculum documents and the structural conditions that maintain it. The five patterns provide evidence of what Apple (2012) describes as ideological curriculum decisions: decisions that determine whose knowledge is taught, whose traditions are centred, and whose design expertise is positioned as disciplinary norm.

6. Limitations

Document analysis captures the curriculum as a written, fixed structure and not its implementation in teaching practice. Actual teaching practice may exceed or fall short of what the curriculum prescribes. Likewise, culturally responsive practices may occur in the classroom without being explicitly stated in the written materials. The scorecard results thus reflect the structural conditions created by the curriculum, not the full spectrum of student experience.

This study examined a single course at one institution, and the scoring was conducted by a single researcher. The adapted tool has not yet been tested in different contexts or by multiple assessors. Further research is needed to test the instrument in other design programs, at other institutions, and in other practice-based disciplines, and to determine whether multiple assessors produce consistent results.

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Understanding Student Preference for Universities Over TVET Colleges: A Conceptual Analysis of Perceptions and Institutional Factors

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Abstract

The persistent preference of students for universities over Technical and Vocational Education and Training (TVET) colleges in South Africa remains a critical concern, particularly in the context of youth unemployment and ongoing skills shortages. Despite the strategic role of TVET institutions in providing practical, industry-relevant skills, enrolment patterns continue to favour traditional university pathways. This conceptual study examines the determinants of students' preference for universities over TVET colleges, with a specific focus on perceptions of digital readiness. Drawing on Human Capital Theory, Social Influence Theory and Institutional Theory, the study integrates traditional factors awareness, employability expectations, curriculum relevance and institutional credibility with contemporary digital transformation perspectives. A conceptual research design is adopted, grounded in a narrative and critical review of recent literature, through which key constructs and relationships are synthesised into an integrated framework. The synthesis indicates that limited awareness of TVET opportunities, negative societal perceptions, perceived differences in employability outcomes and institutional factors such as infrastructure and reputation shape student preferences. Perceptions of digital readiness play a significant role in shaping student choice, with universities generally perceived as more digitally advanced and better aligned with the Fourth Industrial Revolution, while TVET colleges are often viewed as less digitally equipped. The study contributes a digitally grounded conceptual perspective on student preference and provides practical insights for policymakers and institutions seeking to enhance the relevance, competitiveness and attractiveness of vocational education in South Africa. Although developed in the South African context, the framework is positioned as transferable to comparable developing country systems, offering a shared analytical basis for transnational cooperation on vocational education reform and a structure that is amenable to empirical testing.

Keywords: *Student preference; TVET colleges; universities; digital readiness; digital transformation; higher education choice; South Africa*

1. Introduction

South Africa's Technical and Vocational Education and Training (TVET) colleges were redesigned after 1994 to produce the artisans and technicians on whom the country's industrial base depends, with an explicit mandate to bridge mass post-school enrolment and a labour market starved of intermediate skills [1, 2]. Three decades on, school-leavers continue to choose universities first. TVET enrolment lags, public esteem stays low, throughput rates are weak and graduate unemployment persists in ways that contradict the sector's developmental promise [3, 4]. The Fourth Industrial Revolution (4IR) has sharpened the puzzle: employers now expect graduates to combine technical competence with digital fluency and adaptability [5, 6], and the COVID-19 pandemic exposed the digital fragility of many vocational institutions, widening the perceived distance between universities and TVET colleges [1, 7, 8].

Why, then, do students continue to prefer universities over TVET colleges? How do awareness, social influence, employability expectations and institutional characteristics interact to produce this preference, and how do digital readiness perceptions reshape an already lopsided choice in a 4IR economy? Although scholarship on TVET, on student career choice and on digital readiness has grown rapidly, these strands have run in parallel rather than in dialogue. This paper bridges them, drawing on Human Capital Theory, Social Influence Theory and Institutional Theory to develop an integrated conceptual framework of student preference in South African post-school education one that places digital readiness perceptions at its centre rather than at its margins. South Africa's TVET sector confronts a paradox of persistent under-utilisation. Vocational education is consistently identified as critical to

addressing youth unemployment and skills shortages, yet students continue to favour universities at the expense of strategic alignment with labour market need [3, 6]. Negative public perceptions, weak articulation between TVET qualifications and further study, and limited awareness of vocational career pathways entrench the pattern [2, 9]. The challenge has taken on new dimensions in the digital era. As employers increasingly expect digital competencies, perceptions of how well institutions prepare students for digitally mediated work have become consequential to higher education choice [5, 10]. Universities are routinely positioned as more digitally advanced and 4IR-aligned, while TVET colleges are often perceived as digitally underdeveloped [7, 11]. Existing scholarship, however, treats these phenomena in isolation. Studies of career choice focus on socio-economic and peer influences but rarely engage with digital perceptions; work on digital readiness focuses on infrastructural deficits but rarely connects to the moment of student choice. There is no coherent conceptual account that integrates traditional determinants of higher education choice with the digital readiness perceptions now refracting them. This study addresses that gap. The study aims to develop a conceptual framework that explains the determinants of student preference for universities over TVET colleges in South Africa, with particular attention to perceptions of digital readiness. It seeks to synthesise traditional determinants of higher education choice with contemporary digital readiness considerations, advancing scholarly understanding of student preference patterns and providing an integrated basis for policy and institutional response within South Africa's 4IR agenda. Although anchored in the South African case, the perceptual undervaluation of vocational education relative to university study that the framework describes recurs across many developing and transitional economies, positioning the framework as a basis for comparative analysis and transnational cooperation on TVET repositioning. The primary research question is: What factors shape student preference for universities over TVET colleges in South Africa, and how do perceptions of digital readiness contribute to this preference? Three secondary questions extend the inquiry: How do awareness, societal perceptions and employability expectations influence student choice between universities and TVET colleges? What institutional factors infrastructure, reputation, curriculum relevance shape student preferences? And how can existing theoretical perspectives be integrated into a conceptual framework that explains student preference for universities over TVET colleges in a 4IR context? In addressing the research questions, the study pursues four objectives: to examine the role of awareness, societal perceptions and employability expectations in shaping student preferences; to analyse institutional factors influencing higher education choice; to explore the influence of digital readiness perceptions on student decision-making in the South African post-school context; and to synthesise these elements into an integrated conceptual framework that explains student preference for universities over TVET colleges.

The remainder of the paper is structured as follows. Section 2 reviews the related literature across five thematic clusters. Section 3 details the research methodology. Section 4 develops the theoretical foundation drawing on Human Capital Theory, Social Influence Theory and Institutional Theory. Section 5 presents the findings across six interrelated themes. Section 6 proposes the integrated conceptual framework. Section 7 sets out the implications for policy and practice, and Section 8 concludes the paper.

2. Review of Related Literature

The relevant scholarship is reviewed across five thematic clusters that surface the constructs the framework will integrate.

2.1 TVET in South Africa

The South African TVET sector inherits a difficult institutional history. The apartheid legacy shaped vocational education as a racially stratified, under-resourced system [2]. Post-1994 reforms sought to reposition TVET as an 'institution of choice', yet low public esteem, underfunding, weak articulation with universities and poor graduate outcomes continue to constrain the sector [1, 3]. [4] show how structural and attitudinal barriers compound for students with disabilities in Gauteng TVET colleges, while [3] demonstrates that misalignments between National Certificate (Vocational) qualifications and both employer expectations and university entry requirements restrict graduate progression.

2.2 Student Perceptions and Career Choice

Career choice in vocational education is shaped by personal interest, parental guidance, perceived employability and peer influence [12, 13, 14, 15]. Within South African TVET, [9] shows that limited

understanding of career pathways contributes to disengagement and poor completion, while [16] report that perceptions of TVET attractiveness vary along demographic lines unrelated to programme quality. [17] and [18] identify information asymmetry and perceived employability as the dominant determinants of TVET institutional choice in East African contexts. That information asymmetry and perceived employability recur as dominant determinants across East African and Southeast Asian settings [16, 17, 18] points to a cross-national pattern, suggesting that the drivers of vocational education choice are not uniquely South African but shared across developing systems, and are therefore amenable to transnational comparison and cooperation.

2.3 Digital Readiness and E-Learning

Digital readiness has expanded rapidly as an object of TVET research post-pandemic. [11] find that South African TVET engineering lecturers hold positive attitudes towards technology-assisted teaching but report significant digital skills deficits. [7] report inconsistent e-learning integration at a Free State TVET college, while [19] documents foundational digital competency gaps among first-year students. [8] trace these gaps upstream to under-resourced secondary schools, [20] and [21] identify lecturer competence and institutional support as critical determinants.

2.4 Institutional Reputation and Employability

Institutional reputation and graduate employability are tightly coupled in higher education choice. [17] and [15] identify reputation and infrastructure as primary drivers of TVET selection, findings corroborated for South Africa by [2]. On employability, Mbambo and du Plessis [6] establish a significant relationship between TVET students' digital skills deficits and poor throughput, [22] document a substantial divergence between students' self-perceived work readiness and employer expectations, [10] show that perceived digital-era work readiness predicts employability competency, and [23] attributes weak job-entry preparedness to limited industry exposure.

2.5 4IR and Digital Transformation in TVET

4IR discourse has reshaped expectations of South African post-school education. [1] argues that the pandemic exposed a substantial distance between policy aspirations and TVET institutional capacity. [5] treats 4IR preparedness as a stakeholder construction constitutive of institutional legitimacy, while [6] link student digital skills directly to throughput, framing 4IR competence as a precondition for vocational success. 4IR readiness now operates as a foundational expectation rather than an optional modernisation agenda.

3. Research Methodology

The study is conceptual, based exclusively on secondary data, employing a narrative and critical literature review with thematic synthesis. No human participants were recruited and no primary data were collected. Methodological choices follow [24] for conceptual research design, [25] for narrative review and [26] for thematic analysis trustworthiness. Searches were conducted across six databases Scopus, Google Scholar, Web of Science, ScienceDirect, JSTOR and EBSCOhost combining key co nstructs through Boolean operators ('TVET South Africa', 'university preference', 'digital readiness TVET', '4IR TVET', 'employability TVET', 'higher education choice South Africa'), supplemented by snowballing from reference lists. Sources were included where published in English between 2011 and 2025 and focused on TVET, higher education choice, digital readiness or career readiness in South African or comparable developing country contexts; foundational theoretical works prior to 2011 were retained where conceptually indispensable. Thematic synthesis followed the six phases set out by [26]: familiarisation, initial coding, searching for themes, reviewing themes, defining and naming themes, and producing the report. Trustworthiness was supported through the four criteria credibility (triangulating evidence across sources), transferability (rich contextual description of the South African TVET environment), dependability (documenting analytical decisions) and confirmability (maintaining a traceable trail from coded passages to themes). The six themes were then mapped to the three theoretical lenses and synthesised into the conceptual framework in Section 6, with each directional pathway supported by at least two sources from the reviewed literature.

4. Theoretical Foundation

Three theoretical lenses inform the framework. Human Capital Theory conceptualises education as an investment in productive capacity yielding future returns in employability and earnings; students rationally compare expected returns on competing pathways [10, 13, 22], and digital competencies are increasingly central to perceived returns [5, 6]. Social Influence Theory addresses how attitudes and decisions are shaped by parents, peers, teachers and reference groups, operating through informational and normative channels; African scholarship consistently shows career choice mediated by these influences [9, 12, 13, 14, 15]. Institutional Theory examines how legitimacy, conferred by reputation, accreditation and visible markers of quality, conditions individual choice [2, 17]; South Africa's differentiated post-school system has established universities as the most legitimate destination, with TVET colleges positioned as less prestigious [1, 3], and digital readiness now contributes to institutional legitimacy by signalling alignment with contemporary 4IR expectations [5, 11].

5. Findings

Six interrelated themes emerge from the synthesis, each engaged critically and linked explicitly to student preference.

Theme 1: Societal Perceptions of TVET

Societal stigma is a powerful constraint on TVET attractiveness, but scholars account for it differently. [3] treats stigma as an outcome of structural articulation failures; [4] locate it at the intersection of disability and vocational identity; [2] trace it to the historical-symbolic ordering of South Africa's differentiated post-school system. These accounts capture different facets of a layered phenomenon-structural, intersectional and historical. Scholars further disagree on whether perceptions are malleable through targeted intervention [16] or sedimented in the political economy of unemployment [9, 23]; the evidence supports a middle position where perception shifts most reliably when narrative work and substantive institutional change move together. For student preference, prospective students rarely encounter empirical employment data; they encounter narratives transmitted through family, peers and media that position TVET as second-best, driving university choice by social default. Under Social Influence Theory, the channels that transmit stigma must also become those through which TVET's repositioning is propagated.

Theme 2: Perceived Employability Differences

[6], [22] and [10] converge on the digital framing of TVET employability but diverge on its locus; [6] place it on the supply side (graduates lack digital competencies), [22] in self-perception (students underestimate readiness), and [23] in curriculum design and limited industry exposure. The three readings triangulate three reinforcing weaknesses, implying complementary interventions. For student preference, prospective students lack disaggregated labour market data on TVET versus university outcomes; what they have is a generalised perception, now travelling through a digital register, that university graduates fare better. Read through Human Capital Theory in 4IR terms, expected returns to a TVET investment depend on perceived digital readiness as much as on perceived technical training, so university preference partly tracks a digitally inflected employability calculation that disadvantages TVET.

Theme 3: Digital Readiness and Technology Infrastructure

South African TVET literature documents real digital readiness deficits infrastructural constraints, lecturer skills gaps and student competency gaps [6, 7, 11, 19] that [8] trace upstream to under-resourced secondary schools. Scholars locate the deficit at different system levels (lecturer capability, platform usability, school-level digital inequality), amounting to a system-level diagnosis that requires whole-of-system responses. For student preference, digital readiness has two faces: the institutional-real and the perceptual. Under Institutional Theory, what shapes preference is the visible markers of digital readiness, not the underlying capability. Improvements in digital infrastructure must therefore be accompanied by deliberate communication; otherwise the perception lag persists and prospective students continue to choose universities on perceptual grounds.

Theme 4: Institutional Reputation and Credibility

Two competing accounts of reputation run through the scholarship. The first treats it as a reflection of underlying institutional quality; the second, drawn from Institutional Theory, treats legitimacy as its own resource, partially decoupled from underlying performance. [17] shows that perceptions of credibility persist even when programmes improve, while [8] and [7] show students basing judgements on visible markers devices, connectivity, modern facilities that can be improved relatively quickly. The implication is a dual-track logic in which substantive quality improvement is necessary but not sufficient, requiring deliberate reputation management alongside quality work. For student preference, university choice is reinforced by reputational asymmetries that predate the moment of decision; universities benefit from longer histories of investment and the structural privileging of academic over vocational qualifications, leaving TVET colleges to encounter a credibility ceiling that depresses enrolment even where programme quality is sound.

Theme 5: Awareness and Understanding of TVET Pathways

Where prospective students do not understand what TVET qualifications offer or what careers they lead to, the choice between TVET and university is not a genuine comparison but a default to the more familiar option [9, 16, 17]. [12], [13] and [14] underscore the role of parental and peer guidance, suggesting that awareness work must engage the wider social environment rather than the prospective student alone. For student preference, university choice partly tracks the unequal visibility of options rather than considered comparison. Awareness intersects with digital readiness perceptions: students who learn about TVET through outdated websites or thin digital outreach infer that TVET institutions themselves are digitally underdeveloped, so the communicative infrastructure of TVET becomes part of how its institutional substance is perceived.

Theme 6: 4IR Preparedness and Future Employability

The sixth theme draws the other five together. 4IR readiness has become central to how students, families and employers evaluate post-school institutions [5, 6, 10]. [5] treats 4IR preparedness as a stakeholder construction; [6] connect it to throughput and labour market outcomes; [10] link it to individual employability competency. These contributions disagree on what 4IR preparedness requires a skills agenda, an institutional reorientation agenda, or a self-efficacy agenda implying complementary investments rather than mutually exclusive ones. For student preference, perceptions of 4IR preparedness operate as a perceptual lens through which the other five themes are now refracted, shaping awareness, societal perceptions, employability expectations, institutional reputation and perceived digital readiness. Where TVET is seen to lag the 4IR, every other determinant tilts further towards university choice. Repositioning TVET requires reframing the meaning of vocational education in a digitally mediated society, not just upgrading digital infrastructure.

6. Proposed Conceptual Framework

The themes synthesised in Section 5 imply a system of directional relationships among eight constructs: awareness of TVET opportunities, social influence, 4IR preparedness, digital readiness, institutional reputation, employability expectations, student perceptions and student preference decisions. The framework organises these into four layers: an antecedent layer (awareness, social influence, 4IR preparedness) carrying the contextual forces in which choice is made; a mediating institutional layer (digital readiness, reputation, employability expectations) carrying the institutional-level evaluations students form; a synthesising perceptual layer (student perceptions) through which the other layers translate into preference; and an outcome layer (student preference decisions).
Eleven directional relationships connect these constructs (Table 1). Each pathway is anchored in a theoretical lens and supported by at least two sources from the reviewed literature, ensuring that the framework rests on a demonstrable evidential base rather than conceptual assertion alone.

Table 1. Directional Relationships in the Proposed Conceptual Framework

Path	Relationship (Source → Target)	Theoretical Anchor	Justification and Literature Support
R1	Awareness → Student perceptions	Social Influence (informational)	Limited or inaccurate information about TVET produces weaker perceptions of attractiveness [9, 16, 17].
R2	Social influence → Student perceptions	Social Influence (normative)	Parents, peers, teachers and media shape evaluation of post-school options [9, 12, 13].
R3	Social influence → Awareness	Social Influence (mediating)	Information about TVET reaches students through social channels, so the social environment moderates the awareness signal [13, 17].
R4	4IR preparedness → Digital readiness	Institutional Theory	4IR discourse sets the benchmark against which institutional digital readiness is now assessed [1, 5, 6].
R5	4IR preparedness → Employability expectations	Human Capital (4IR-inflected)	4IR-relevant skills increasingly shape employer evaluation of graduates [5, 10, 22].
R6	4IR preparedness → Institutional reputation	Institutional Theory	Legitimacy is now partly conferred by visible alignment with 4IR expectations [1, 5, 8].
R7	Digital readiness → Institutional reputation	Institutional Theory	Visible markers of digital readiness feed institutional credibility [7, 8, 11].
R8	Digital readiness → Employability expectations	Human Capital Theory	Perceptions of digital capability shape beliefs about graduate employability [6, 19, 22].
R9	Institutional reputation → Student perceptions	Institutional Theory	Reputation and prestige shape how students evaluate enrolment desirability [2, 15, 17].
R10	Employability expectations → Student perceptions	Human Capital Theory	Perceived employability is a consistent driver of post-school preference [10, 13, 22].
R11	Student perceptions → Student preference decisions	Integrated theoretical scaffolding	The composite of antecedent and mediating constructs, refracted through digital readiness and 4IR perceptions, manifests as the observable choice between universities and TVET colleges.

Source: Authors own compilation

Three integrating mechanisms produce the framework's analytical force. First, 4IR preparedness operates as a cross-cutting force feeding digital readiness (R4), employability expectations (R5) and institutional reputation (R6); three of the four mediating pathways into student perceptions are therefore conditioned by 4IR perceptions, so that where TVET is perceived to lag the 4IR every mediator tilts further against it. Second, social influence operates through two pathways simultaneously directly on perceptions (R2) and indirectly via the awareness signal (R3) so that perceptions of TVET are doubly mediated by the social environment. Third, the mediating institutional layer is internally interconnected: digital readiness shapes both reputation and employability, each of which then shapes perceptions, so improvements in perceived digital readiness exert compounded rather than additive effects on student preference. Institutional choice is, fundamentally, perceptual. Students do not directly observe infrastructure, lecturer capability or graduate employment outcomes; they observe perceptions of these things, transmitted through social, informational and digital channels. R11 is therefore the binding pathway of the entire framework: every other relationship feeds into perceptions, and perceptions drive choice. The three theoretical anchors converge on this point Human Capital Theory holds that students choose on perceived rather than actual returns; Social Influence Theory holds that perceptions are socially mediated; Institutional Theory holds that legitimacy is conferred by perceptions of relevant audiences. In South Africa, universities benefit from advantages on all three dimensions while TVET colleges face a triple disadvantage on the perceptual register, intensified by 4IR perceptions. The framework yields four testable propositions: (P1) preference is shaped by an interacting system of antecedent, mediating, perceptual and outcome layers rather than by any single determinant; (P2) 4IR

preparedness perceptions condition the influence of digital readiness, reputation and employability expectations on student perceptions; (P3) social influence operates through both direct and information-mediating pathways, doubling its effect on perceptions of TVET; and (P4) shifting student preference requires engaging capability and perception simultaneously, because perceptions are the binding pathway through which institutional capacity translates into choice.

The framework is deliberately constructed to be empirically testable. Each construct is amenable to measurement: awareness and social influence through survey scales adapted from career choice research, digital readiness and 4IR preparedness perceptions through validated perception instruments, institutional reputation through established legitimacy and image scales, and student preference through stated and revealed choice measures. The eleven directional relationships (R1 to R11) can be estimated using structural equation modelling on cross-sectional survey data from prospective and enrolled students, while the mediating and moderating roles specified in P1 to P4 lend themselves to mediation and moderated mediation analysis. Multi-group testing across provinces, and across comparable developing country systems, would establish the framework's boundary conditions and its transnational generalisability, converting the conceptual scaffolding into a verifiable model.

7. Implications for Policy and Practice

Single-lever interventions are unlikely to succeed. A coordinated, multi-pronged response is required in which substantive improvements in institutional capacity move together with deliberate work on the perceptual environment in which TVET is evaluated. For policymakers and institutional leaders, this means combining investment in TVET digital infrastructure, lecturer professional development and curriculum modernisation with targeted communication campaigns to reshape public perceptions. The Department of Higher Education and Training, working with employer associations, student support organisations and community structures, has a particular role in reframing TVET as a credible and aspirational 4IR pathway [1, 5], while articulation between TVET and university qualifications requires policy attention so that students are not penalised for choosing the vocational route [2, 3]. At the institutional level, visible markers of digital readiness modern learning management systems, lecturer digital fluency, student-facing digital experiences communicate institutional readiness directly to prospective students, families and employers [11, 20]. For curriculum practice, 4IR-relevant competencies need to be embedded across vocational programmes rather than treated as bolt-on modules, with industry exposure and work-integrated learning closing the gap between TVET training and employer expectations [10, 22, 23]. To make the framework directly actionable, institutions can translate its constructs into monitorable indicators, for example prospective-student awareness levels, the currency and reach of digital outreach, learning-management-system adoption, lecturer digital-fluency benchmarks and graduate-destination tracking, and then sequence interventions so that visible markers of digital readiness and reputation are communicated to prospective students, families and employers as substantive capacity is built. This gives institutional leaders a staged and measurable basis for applying the framework rather than a purely conceptual account.

Beyond the national level, the convergence of vocational education challenges across developing systems creates clear scope for transnational cooperation. Regional bodies and cross-border partnerships, for instance within the Southern African Development Community and through wider South-to-South knowledge exchange, can pool scarce resources for digital infrastructure, share curriculum frameworks for 4IR-relevant competencies, and coordinate the reputational repositioning of vocational education. The comparable patterns reported in East African and Southeast Asian studies [16, 17, 18] indicate that this is a shared rather than a purely South African problem, and that instruments, interventions and lessons are mutually transferable across systems facing similar perceptual and structural constraints. Embedding the framework within such cooperative arrangements would strengthen both its evidentiary base, through coordinated comparative testing, and its practical reach, directly connecting the analysis to the transnational cooperation agenda in post-school education.

8. Conclusion

This paper has examined the persistent preference of South African students for universities over TVET colleges in a labour market that increasingly requires the skills TVET is designed to deliver, and has proposed a conceptual framework to explain this enrolment pattern. Drawing on Human Capital Theory, Social Influence Theory and Institutional Theory and synthesising literature predominantly from the 2021–2025 period, the framework identifies six determinants of preference and positions perceptions of digital readiness and 4IR preparedness as a cross-cutting perceptual layer that conditions every

determinant. The four research objectives are addressed: the role of awareness, societal perceptions and employability expectations is analysed in Themes 1, 2 and 5 of Section 5; institutional factors are analysed in Theme 4; the influence of digital readiness perceptions is analysed in Themes 3 and 6; and the integrated framework is presented in Section 6. The substantive conclusion is that university preference cannot be adequately explained by any single determinant. It is the product of layered interactions among economic calculation, social influence, institutional legitimacy and digital perceptions, with 4IR-related perceptions intensifying every layer of disadvantage TVET faces. Repositioning TVET within South Africa's post-school education system is therefore a core component of the country's 4IR response. As a conceptual study, this paper does not generate primary empirical data; its four propositions await testing through quantitative modelling, qualitative inquiry into perception formation and comparative work across provinces and other developing country contexts. In particular, the eleven pathways and four propositions can be operationalised and tested through structural equation modelling and comparative, transnational designs that examine whether the same perceptual mechanisms operate across developing country TVET systems, providing an evidentiary basis for cooperative regional responses and stronger evidence of the framework's practical applicability. The contribution is the conceptual scaffolding on which such empirical work can build.

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Higher Education in Morocco: Promoting Innovation through Human Capital Development

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Abstract

In the context of accelerating global competitiveness and structural reform, innovation has emerged as a central organizing principle of higher education policy worldwide. In Morocco, universities are increasingly positioned as engines of economic growth and employability enhancement. However, prevailing reform discourses tend to equate innovation with technological modernization, institutional restructuring, and entrepreneurial performance, thereby narrowing its pedagogical and developmental dimensions.

This paper advances a reconceptualization of innovation in Moroccan higher education through a human capital development framework that integrates cognitive, socio-behavioral, and ethical competencies alongside disciplinary expertise. Drawing on innovation systems theory and human capital scholarship, the study argues that sustainable innovation requires more than institutional reform; it necessitates the cultivation of transferable skills that enable adaptive, collaborative, and socially responsible graduates. Using English for Specific Purposes (ESP) as a strategic pedagogical locus, the paper proposes a competence-oriented approach that repositions language education as a site of integrated skill formation rather than merely disciplinary specialization. By situating ESP within broader innovation and human capital debates, the study highlights its potential contribution to socially embedded and development-oriented innovation in Morocco. The paper concludes that aligning innovation policy with holistic human capital formation is essential for achieving both economic competitiveness and sustainable societal transformation.

Keywords: *Human capital development, ESP, sustainable innovation, Moroccan higher education reform.*

1. Introduction: The Innovation Imperative in Moroccan Higher Education

Innovation has emerged as a defining paradigm shaping contemporary higher education systems operating within increasingly competitive and knowledge-driven economies. Globally, universities are no longer conceived solely as sites of knowledge transmission but as strategic actors within national innovation systems, expected to contribute directly to economic growth, technological advancement, and workforce competitiveness. Within this policy landscape, innovation functions both as an institutional survival strategy and as a developmental imperative.

Moroccan public universities are deeply embedded in this global reform dynamic. Confronted with economic restructuring, demographic pressures, globalization, and labor-market volatility, they are increasingly called upon to produce graduates equipped not only with disciplinary knowledge but also with adaptive and transferable competencies. Recent reform initiatives—including the restructuring of degree architecture toward a bachelor-based model and the reinforcement of multilingual education policies—reflect an explicit commitment to modernization and employability enhancement. These reforms signal Morocco's alignment with broader international trends linking higher education performance to innovation capacity.

Yet a critical question persists: **What conception of innovation should guide Moroccan higher education reform?**

While policy discourse often equates innovation with structural reorganization, technological upgrading, or entrepreneurial output, such interpretations risk reducing innovation to an economic performance indicator. When framed narrowly, innovation becomes a rhetorical instrument legitimizing reform without necessarily transforming pedagogical practices or student development processes. The result is a reform agenda focused on institutional adjustment rather than human capability formation.

This paper argues that innovation in Moroccan higher education must be reconceptualized through a human capital development framework that integrates cognitive, socio-behavioral, and ethical competencies alongside disciplinary expertise. Drawing on innovation systems theory and human capital scholarship, the study contends that sustainable innovation cannot be achieved through

structural reform alone; it requires the deliberate cultivation of transferable skills, adaptive expertise, and socially responsible agency. By repositioning innovation as a multidimensional developmental process rather than a purely economic objective, Moroccan higher education can move beyond modernization rhetoric toward meaningful institutional and pedagogical transformation.

2. Conceptualising Innovation: Beyond Reform & Change

Innovation is frequently conflated with reform, modernization, or institutional change. Yet the literature draws important distinctions between these concepts. Reform may introduce structural adjustments, policy modifications, or administrative reorganization without fundamentally transforming institutional practices or outcomes. Innovation, by contrast, is generally conceptualized as a multi-stage process involving the generation, implementation, diffusion, and evaluation of novel ideas that produce demonstrable value or impact (Baregheh, Rowley, & Sambrook, 2009; Tierney & Lanford, 2016).

In this sense, innovation cannot be reduced to the mere introduction of new structures or policies. It entails at least four interrelated dimensions: **novelty**, understood as the introduction of new approaches or practices; **implementation**, referring to the effective operationalization of those ideas; **evaluation**, involving systematic assessment of outcomes; and **measurable impact**, which indicates tangible improvement in performance, quality, or societal contribution. Without these elements, institutional initiatives risk remaining symbolic gestures rather than substantive transformation.

Within higher education, innovation may manifest in multiple domains, including curriculum redesign, pedagogical experimentation, digital integration, research collaboration models, or governance restructuring. However, the presence of novelty alone does not guarantee innovation. As innovation systems scholarship emphasizes, successful innovation depends on coherence between institutional culture, incentive structures, leadership vision, and pedagogical practice. When innovative ambitions are not embedded within supportive organizational ecosystems, reforms often result in fragmented or superficial adoption.

The Moroccan higher education system currently confronts this structural tension. Over recent decades, expansion policies have increased access and diversified institutional offerings. Yet quantitative growth has not always been accompanied by corresponding qualitative transformation in learning outcomes, graduate adaptability, or knowledge transfer capacity. This disjunction highlights the limits of reform understood primarily as structural adjustment.

Accordingly, innovation in Moroccan higher education must be reconceptualized not as incremental modification but as purpose-driven educational redesign. Such redesign requires alignment between policy objectives, pedagogical strategies, and human capital development goals. Only through this integrative approach can innovation transcend rhetorical invocation and become a driver of sustainable institutional and societal advancement.

3. Reclaiming Impact: Economic and Social Dimensions

Contemporary innovation discourse in higher education is frequently framed in economic terms. Institutional success is often measured through graduate employability rates, alignment with labor-market demands, entrepreneurial output, and contribution to national competitiveness. While these indicators remain significant—particularly within developing and emerging economies—a purely utilitarian interpretation of innovation risks narrowing the normative mission of the university.

Reducing innovation to economic productivity alone overlooks the broader civic and developmental responsibilities historically associated with higher education. Universities are not merely engines of workforce preparation; they are also sites of intellectual formation, ethical reflection, and social transformation. A more comprehensive understanding of impact must therefore extend beyond employability to encompass civic engagement, ethical awareness, personal growth, and social responsibility.

From this broader perspective, innovation involves cultivating individuals capable not only of adapting to existing economic systems but also of critically evaluating and reshaping them. Graduates should possess the reflective capacity to interrogate social challenges, the ethical grounding to act responsibly, and the communicative competence to participate meaningfully in public discourse. Innovation, in this sense, becomes as much about social contribution and institutional trust as it is about market performance.

1. This dual orientation challenges the dominance of market-centered models of higher education and calls for a hybrid framework in which instrumental and intrinsic purposes coexist. The following diagram clearly demonstrates that Economic competitiveness and social development should not be positioned

as mutually exclusive objectives; rather, they must be understood as interdependent dimensions of sustainable innovation.

"An educational system that prioritizes only short-term employability may undermine the long-term adaptive capacity and civic resilience required for enduring national progress."



Fig. 1. Dual-Dimension Model of Innovation Impact in Higher Education

The above Dual-Dimension Model illustrates that sustainable innovation in higher education cannot be achieved by optimizing either economic or social objectives in isolation. The **left circle** represents *Economic Vitality and Competitiveness*—encompassing graduate employability, entrepreneurial output, and labor-market alignment. The **right circle** captures *Social Responsibility and Ethical Advancement*—encompassing civic engagement, ethical reflection, and social transformation. The intersection—**Sustainable Innovation Capacity**—is the zone where both dimensions converge, and where transformative innovation becomes possible.

2. For Moroccan higher education, reclaiming this broader conception of impact is particularly urgent. As institutions navigate reform pressures and global benchmarking regimes, innovation must be anchored in a balanced human capital strategy—one that integrates economic vitality with ethical and societal advancement. Only through such equilibrium can innovation move beyond performance metrics to become a transformative force within both the university and society at large.

4. Human Capital Development as a Lever for Innovation

Innovation is fundamentally human-driven. Its sustainability does not reside in policies, technologies, or institutional restructuring alone, but in the competencies, dispositions, and cognitive capacities of individuals. Educational transformation, therefore, cannot occur without parallel human capital development.

Human Capital Theory, as articulated by Schultz (1961) and later developed by Becker (1964), conceptualizes education as an investment that enhances productivity and economic growth. Within this framework, skills acquisition is primarily justified by its contribution to labor-market efficiency and national competitiveness. While this economic rationale remains influential—particularly in policy discourse—it has been widely critiqued for reducing individuals to instruments of economic output and for overlooking broader developmental and social dimensions of education.

In response to these limitations, contemporary perspectives such as Strategic Human Resource Management (SHRM) and knowledge-based organizational theory reconceptualize individuals not as passive labor-market inputs but as active agents of innovation. From this standpoint, competitive advantage emerges not merely from technical expertise, but from higher-order competencies that

enable adaptability, creativity, and collaborative problem-solving (Wright & McMahan, 1992; Teece, 2007). Innovation capacity becomes embedded in people rather than structures alone.
Applied to higher education, this shift necessitates a reorientation from narrow employability metrics toward the cultivation of transferable and transformative competencies. These include critical thinking, creativity, adaptability, communication proficiency, ethical judgment, and lifelong learning dispositions. Such capacities allow graduates not only to integrate into existing professional environments but also to reshape them. Innovation thus becomes generative rather than reactive.
For Moroccan higher education, adopting this developmental lens is particularly significant. In a context marked by rapid socio-economic transformation and evolving labor-market demands, graduates must be equipped not simply to access employment but to navigate uncertainty, initiate change, and contribute to institutional and societal renewal. Innovation, therefore, should be conceptualized as a byproduct of empowered human capital—individuals capable of synthesizing knowledge, exercising judgment, and acting responsibly within complex systems.
Shifting toward this transformative model does not negate the importance of employability. Rather, it reframes employability as an outcome of deeper intellectual and personal development. When higher education prioritizes transferable competencies and reflective capacity, it strengthens both economic resilience and social sustainability.

5. English for Specific Purposes (ESP) as a Strategic Site of Innovation

Within Moroccan universities, English for Specific Purposes (ESP) was initially introduced to enhance students' disciplinary communication competence and facilitate access to global academic and professional communities. Its expansion reflects broader multilingual and modernization policies seeking to strengthen graduate competitiveness. However, despite its strategic positioning within reform agendas, ESP has not consistently fulfilled its transformative potential. Structural and pedagogical constraints—including large and heterogeneous classes, grammar-centered teaching practices, limited disciplinary collaboration, and insufficient curricular coherence—have often reduced ESP to a supplementary language requirement rather than a developmental platform.
Moreover, traditional ESP frameworks have tended to remain narrowly disciplinary, emphasizing terminology acquisition and field-specific communicative conventions. While such objectives are essential, this orientation alone does not sufficiently address the broader human capital demands associated with sustainable innovation. As argued in the preceding sections, innovation capacity depends not only on technical expertise but also on transferable cognitive and socio-behavioral competencies. When ESP is confined to lexical specialization, it risks underutilizing its inherently interactive and communicative pedagogical structure.
Repositioned within a human capital development framework, ESP emerges as a uniquely strategic site for cultivating innovation-oriented competencies. Its dialogic format, reliance on problem-based tasks, emphasis on negotiation of meaning, and engagement with professional scenarios create fertile conditions for developing critical reasoning, leadership capacity, collaborative problem-solving, interpersonal communication, and self-awareness. These competencies align closely with the multidimensional skill architecture required for innovation in contemporary knowledge economies.
A reformed ESP framework, therefore, should move beyond disciplinary language transmission toward an integrated, skill-based innovation model. Such a model would explicitly bridge language learning with societal and labor-market realities, embedding authentic professional challenges within communicative tasks. Soft skills would be systematically integrated into project-based learning and reflective activities rather than treated as incidental by-products of language instruction. Interdisciplinary collaboration between language instructors and subject specialists would enhance contextual relevance, while research-informed pedagogical experimentation would ensure continuous evaluation and adaptation.
In this configuration, ESP occupies a strategic intersection between personal development, professional readiness, and social responsibility. It becomes not a remedial or peripheral course, but a structured environment for cultivating adaptive expertise and reflective agency across disciplines. By aligning communicative competence with transferable skill formation, ESP can function as a micro-level pedagogical lever within broader institutional innovation strategies.
For Moroccan higher education, such repositioning holds particular significance. As universities seek to reconcile economic competitiveness with social transformation, ESP provides a scalable and cross-disciplinary mechanism through which innovation-oriented human capital can be systematically nurtured. The challenge, therefore, is not merely to reform ESP structurally, but to reconceptualize its epistemological purpose within the innovation agenda.

6. Conclusion: Toward Transformative Innovation in Moroccan Higher Education

Innovation has become an unavoidable imperative within contemporary higher education reform. In Morocco, as in many emerging knowledge economies, universities are increasingly expected to align with global competitiveness standards and respond to labor-market demands. Yet, as this paper has argued, equating innovation solely with structural reform, technological modernization, or employability metrics risks narrowing its transformative potential.

Reconceptualizing innovation through a human capital development lens allows for a more comprehensive and sustainable framework. Innovation must be understood not merely as institutional adaptation but as the cultivation of multidimensional competencies that enable individuals to think critically, act ethically, collaborate effectively, and navigate complexity. Economic vitality and social responsibility are not competing objectives; they are interdependent dimensions of durable national progress.

Within this integrative framework, pedagogical spaces that foster communicative interaction, reflective engagement, and interdisciplinary problem-solving acquire strategic importance. Repositioning such spaces as structured environments for transferable skill formation offers a practical pathway through which innovation-oriented human capital can be systematically developed across disciplines.

Future research should therefore move beyond conceptual reframing toward the design and empirical evaluation of pedagogical models capable of operationalizing this human-centered innovation agenda. The challenge ahead lies not in redefining innovation rhetorically, but in embedding it coherently within curricular architectures that translate policy ambition into developmental practice.

Only through such alignment can Moroccan higher education transition from reform discourse to transformative and sustainable innovation.

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STEM-Based Learning Leadership in Elementary Schools

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Abstract

Indonesian learning, the Science, Technology, Engineering, and Mathematics (STEM) approach is recommended as a strategy to improve the quality of education towards a Golden Indonesia, but its implementation is still not optimal. This study aims to develop a STEM-based learning leadership design in elementary schools. The research method uses the ADDIE development design. At the need analysis stage with 120 elementary school principals as subjects, it showed that 67% experienced difficulties in leading STEM integration in learning. The STEM-based learning leadership design consists of 5 aspects, namely leadership in developing a STEM learning environment with local phenomena and establishing a STEM center in schools; leading the planning and implementation of STEM-based learning by applying a project-based learning model; leading reflection on improving the quality of learning; leading the involvement of parents as mentors and STEM learning resources. The results of the model design test from the expert and practitioner groups were in the very feasible category with an average feasibility percentage of 85.68%. At the implementation stage, the response of the principal as a user to the model design was 84.97% in the very satisfied category.

Keywords: *Innovation; Learning Leadership; Deep Learning; STEAM; Elementary Schools*

Introduction

In the pursuit of Indonesian Golden 2045, Indonesia is projected to have a population of more than 320 million people, predominantly within the productive age group, as a result of the demographic dividend. This demographic advantage provides a substantial opportunity to accelerate national development. Nevertheless, the demographic dividend can only be transformed into a sustainable competitive advantage if the Indonesian workforce is equipped with essential 21st-century competencies, particularly the 4C skills of **critical thinking, creativity, communication, and collaboration.** Consequently, the education system must foster learning environments that develop these competencies, enabling students to effectively respond to the complex challenges of the 21st century [1], [2].

Indonesia's education system is currently facing a serious challenge known as *learning loss*. This phenomenon is characterized by a decline in students' learning motivation, comprehension of subject matter, and academic performance. If not addressed effectively, learning loss may hinder the development of essential competencies and negatively affect students' long-term educational outcomes. [3]. The consequences of this condition are evident not only in students' declining academic performance but also in the insufficient development of critical thinking skills, one of the key competencies required in the 21st century. Consequently, there is a need for innovative learning leadership that facilitates the implementation of *deep learning* and the STEAM (*Science, Technology, Engineering, Arts, and Mathematics*) approach. These approaches enable students to actively participate in meaningful learning experiences, address authentic problems, and continuously enhance their critical thinking abilities, preparing them to meet the demands of an increasingly complex and dynamic world.

On the other hand, Indonesia is facing a rapid educational transformation driven by technological advancement, globalization, and the changing demands of the 21st century. This situation requires immediate responses from educational leaders, particularly in ensuring the provision of high-quality learning services. Educational leaders play a crucial role in preparing learning processes that equip students with the knowledge, skills, and competencies needed to remain competitive in the future. However, the results of the 2022 Programme for International Student Assessment (PISA) placed Indonesia below the OECD average in reading, mathematics, and science performance. These international comparative findings highlight persistent challenges in the quality of learning and the development of higher-order thinking skills among Indonesian students. Therefore, strategic innovations in learning leadership are essential to improve educational quality and prepare students to thrive in an

increasingly complex global environment [4].

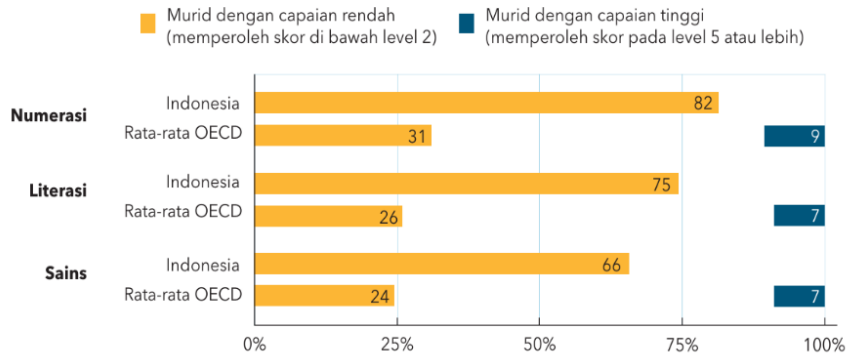


Fig. 1. Percentage of Students Reaching the Minimum Proficiency Level (Level 2 and Above) in PISA 2022 (Source: OECD, 2023)

Figure 1 illustrates the percentage of students achieving proficiency Level 2 or above in PISA 2022. Indonesia's performance remains below the OECD average, indicating persistent challenges in learning quality and the development of higher-order thinking skills. These findings underscore the importance of implementing innovative learning leadership and student-centered instructional approaches to improve educational outcomes. The PISA 2022 assessment revealed a substantial gap in Higher-Order Thinking Skills (HOTS) among Indonesian students. Only 18% of students attained at least Level 2 proficiency in mathematics, compared to 25% in reading and 34% in science. These results suggest that many students have not yet developed the minimum competencies required to effectively analyse information, reason critically, and solve authentic problems. Similarly, students' performance in creative thinking was relatively low, indicating challenges in generating innovative ideas and solutions. Such findings underscore the necessity of strengthening learning practices that promote critical and creative thinking as essential competencies for the 21st century [4]. These findings indicate that learning practices in elementary schools have not yet adequately fostered Higher-Order Thinking Skills (HOTS), which are crucial for success in the 21st century. Consequently, there is a pressing need for innovative educational approaches that provide meaningful learning experiences and encourage active student participation. Learning should move beyond the transmission of knowledge toward engaging students in authentic problem-solving, inquiry, collaboration, and reflection. In this regard, the integration of *deep learning* and the STEAM approach offers a promising framework for cultivating critical thinking, creativity, and lifelong learning skills among elementary school students.

In 2022, Indonesia introduced the *Merdeka Curriculum* as part of its educational reform efforts to enhance learning quality and student competencies. Subsequently, in 2025, the curriculum was strengthened through the adoption of a *deep learning* approach. This approach emphasizes meaningful, contextual, and participatory learning experiences aimed at developing Higher-Order Thinking Skills (HOTS) from an early age. Through deep learning, students are encouraged not only to acquire knowledge but also to analyse, evaluate, and apply their understanding in authentic contexts, thereby fostering critical thinking, problem-solving, creativity, and lifelong learning competencies [5]. These objectives can be achieved through the use of open-ended questions, meaningful discussions, and the exploration of authentic real-world problems. Such learning activities encourage students to actively construct knowledge, reflect on their understanding, and apply concepts in relevant contexts, thereby fostering critical thinking and deeper learning.

In 2025, the Indonesian government recommended the Science, Technology, Engineering, and Mathematics (STEM) approach as a strategic framework for improving educational quality in support of the Golden Indonesia 2045 vision. Furthermore, STEAM (Science, Technology, Engineering, Arts, and Mathematics) learning integrated with interactive media is widely regarded as an effective strategy for fostering critical thinking, creativity, and innovation from an early age. By combining interdisciplinary knowledge with engaging learning experiences, the STEAM approach encourages students to explore, create, solve problems, and develop the competencies needed to thrive in the 21st century [6], [7]. The integration of Arts into the STEM framework has led to the emergence of STEAM (Science, Technology, Engineering, Arts, and Mathematics), a more comprehensive approach that not only enhances logical thinking and problem-solving skills but also promotes creativity, innovation, and design thinking.

Consequently, STEAM is regarded as a more effective approach for fostering the holistic development of twenty-first-century competencies.
Contemporary challenges in Indonesian primary and secondary education extend beyond improving school management quality to ensuring the effective implementation of student-centered learning. Consequently, school principals are required to move beyond traditional administrative and managerial roles and adopt *learning leadership* practices that guide, support, and improve instructional quality. Research has demonstrated that effective learning leadership positively influences student achievement and facilitates the development of key 21st-century competencies, such as critical thinking, creativity, communication, and collaboration. Therefore, strengthening learning leadership is essential for creating meaningful learning experiences and enhancing students' readiness to face future educational and societal challenges [8], [9]. Hattie emphasized that meaningful and student-centered learning has a significant impact on students' academic achievement and the long-term development of learning capabilities. Such learning experiences enable students to actively engage in the construction of knowledge, deepen their understanding of concepts, and develop the cognitive skills necessary for lifelong learning. [10]. Furthermore, Hoskins and Fredriksson argued that the development of higher-order thinking skills should begin in primary education, as this stage represents a critical period for cultivating reflective thinking, problem-solving abilities, and deep learning. These competencies serve as essential foundations for students' future academic success and their ability to adapt to increasingly complex learning environments. [11]. Previous studies have demonstrated that learning leadership, deep learning approaches, and STEAM-based learning, when implemented separately, can improve the quality of learning and students' competencies. However, studies integrating learning leadership, deep learning principles, and the STEAM approach into a comprehensive model for elementary schools remain limited. Furthermore, few studies have developed a learning leadership model specifically designed to enhance elementary school students' critical thinking skills through the integration of deep learning and STEAM.
The novelty of this study lies in the development of a STEAM-based learning leadership model that integrates the principles of deep learning, namely meaningful, mindful, and joyful learning, into learning planning, implementation, reflection, evaluation, and the development of student-centered learning environments to improve elementary school students' critical thinking skills. This study is expected to contribute both theoretically and practically. Theoretically, it enriches the literature on STEAM-based learning leadership and deep learning. Practically, the proposed model can serve as a guideline for school principals and teachers in managing learning processes that are oriented toward the development of students' critical thinking skills. **This study aims to:** (1) analyse the need for STEM-based learning leadership in elementary schools; (2) develop a STEM-based learning leadership model for elementary schools; and (3) evaluate the practicality and effectiveness of the developed STEM-based learning leadership model in enhancing students' critical thinking skills.

Method

This study employed a **Research and Development (R&D)** approach using the ADDIE model [12], [13]. The research was conducted in accredited A-level public and private elementary schools in Kudus Regency, Indonesia. The data sources included school principals, teachers, and students. Data were collected through classroom observations, interviews, and questionnaires. The development process involved two learning experts and two STEM experts from Pendidikan Indonesia University as expert validators. Data were analyse using both quantitative and qualitative approaches.
The product developed in this study was a STEM-based learning leadership model for elementary schools. The ADDIE model proposed by Dick and Carey consists of five development stages: Analysis, Design, Development, Implementation, and Evaluation. During the analysis stage, needs and challenges related to STEM-based learning leadership were identified. The design stage focused on developing the components and framework of the model. The development stage involved expert validation and model revision. Subsequently, the implementation stage tested the model in selected schools, while the evaluation stage assessed the practicality, feasibility, and effectiveness of the model. The research procedure is illustrated in Figure 2.

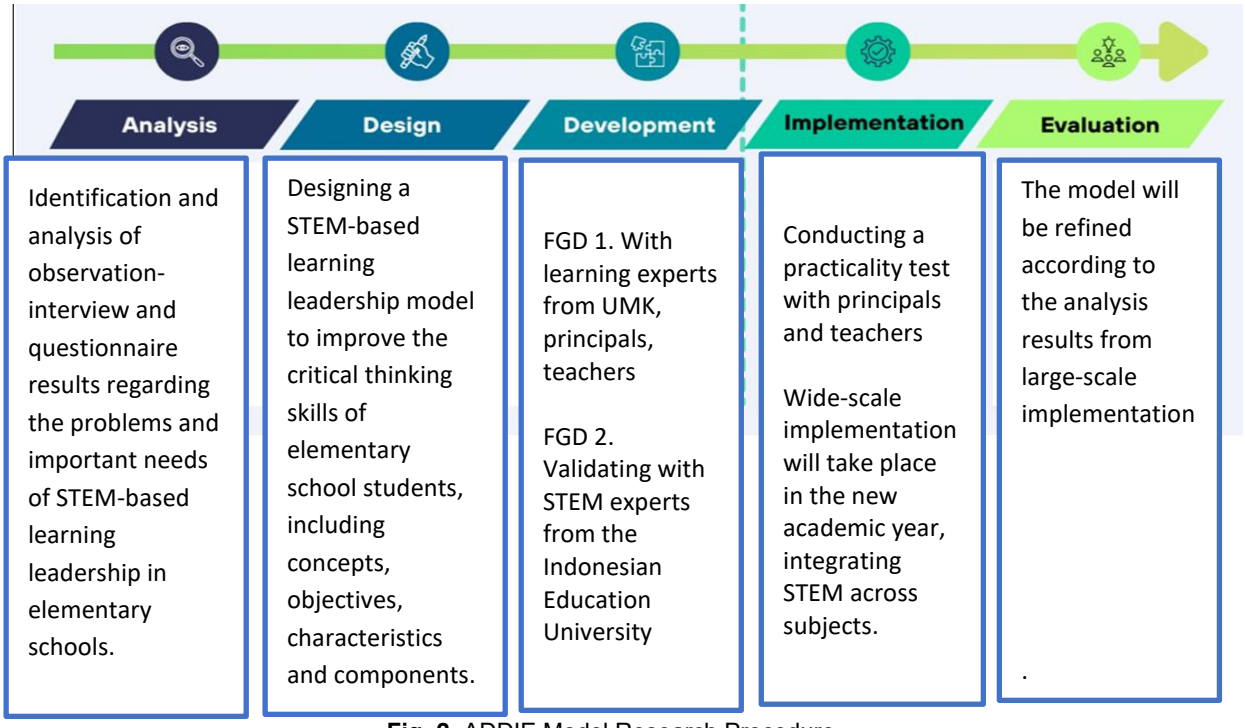


Fig. 2. ADDIE Model Research Procedure

Results

Analysis

Field observations indicate that many teachers have implemented the STEM approach but lack understanding. Interviews with teachers revealed that they are happy to implement the STEM approach, but it requires considerable preparation, infrastructure, and time. Furthermore, teachers must complete the material. A needs analysis involving 120 elementary school principals found that 67% experienced difficulties leading STEM integration in learning. Observation and interviews revealed that 72% of teachers had difficulty integrating STEM into deep learning.

The integration of Arts into the STEM framework has led to the emergence of STEAM (Science, Technology, Engineering, Arts, and Mathematics), which offers a more comprehensive and holistic learning experience [14]. The STEAM approach not only focuses on developing logical thinking, technological literacy, engineering design, and mathematical problem-solving skills, but also fosters creativity, imagination, aesthetics, and design thinking [15]. The inclusion of Arts enables students to connect knowledge across disciplines, generate innovative solutions, and express ideas in more meaningful ways. Previous studies have shown that STEAM-based learning can enhance critical thinking, creativity, collaboration, and problem-solving skills, which are essential competencies for the twenty-first century [16]. Furthermore, STEAM encourages students to engage in authentic, contextual, and interdisciplinary learning experiences, thereby supporting balanced cognitive, affective, and psychomotor development [17]. Therefore, STEAM is considered a more appropriate approach for fostering twenty-first-century competencies in a holistic manner and preparing students to face increasingly complex, dynamic, and technology-driven global challenges [18]. However, the successful implementation of STEAM in schools depends not only on teachers' competencies but also on the ability of school principals to exercise effective learning leadership that guides the planning, implementation, reflection, and evaluation of learning processes on an ongoing basis. Therefore, a STEAM-based learning leadership model is needed to support the implementation of deep learning and enhance elementary school students' critical thinking skills. Previous studies have shown that the integration of technology in learning supported by a sustainable pedagogical framework can enhance student engagement and improve the quality of the learning process [19]. The effective learning management through the use of interactive digital worksheets has been proven to significantly improve students' critical thinking skills and learning outcomes [20]. These findings indicate that innovative learning management and instructional leadership play an important role in creating meaningful learning experiences and fostering students' higher-order thinking skills.

Desain:

- A learning leadership model was developed by integrating the STEM approach.
- Learning leadership applies the management functions of planning, implementation, and evaluation.
- STEM-Based Learning Leadership integrates the principles of deep learning and STEM learning.
- Component 1. Leading the Development of a Student-Oriented Learning Environment.
- Component 2. Leading learning planning, starting with Identifying Problems and Potential, analysing Learning Outcomes (CP) and STEM integration across subjects, establishing STEM projects, and developing learning designs (learning objectives, assessments, activities, environment, and partnerships).
- Component 3. Leading learning implementation by applying the principles of deep learning: Meaningful, Joyful, and Mindful. The learning steps are: 1) Problem and potential analysis; 2) Investigation: designing a design or solution; 3) Testing and shared understanding; 4) Formative and summative assessment
- Component 4. Leading learning evaluation and reflection to determine the achievement of learning objectives and obstacles.
- Component 5, Leading STEM center as part of a learning community for professional development and improving the quality of student learning

Development. The model design was developed collaboratively with experts and practitioners through focus group discussions. Input was obtained for the following components:

1. Leading the development of the learning environment is initially included in the planning phase. It is best to lead efforts to develop a safe and comfortable environment for students before planning.
2. Management functions were removed.
3. Local phenomena should be given more attention to identifying problems and potential.
4. Implementation of STEM-based learning by implementing a project-based learning model elaborated on STEM learning principles.
5. Additionally, leading parent involvement as mentors and resources for STEM learning.

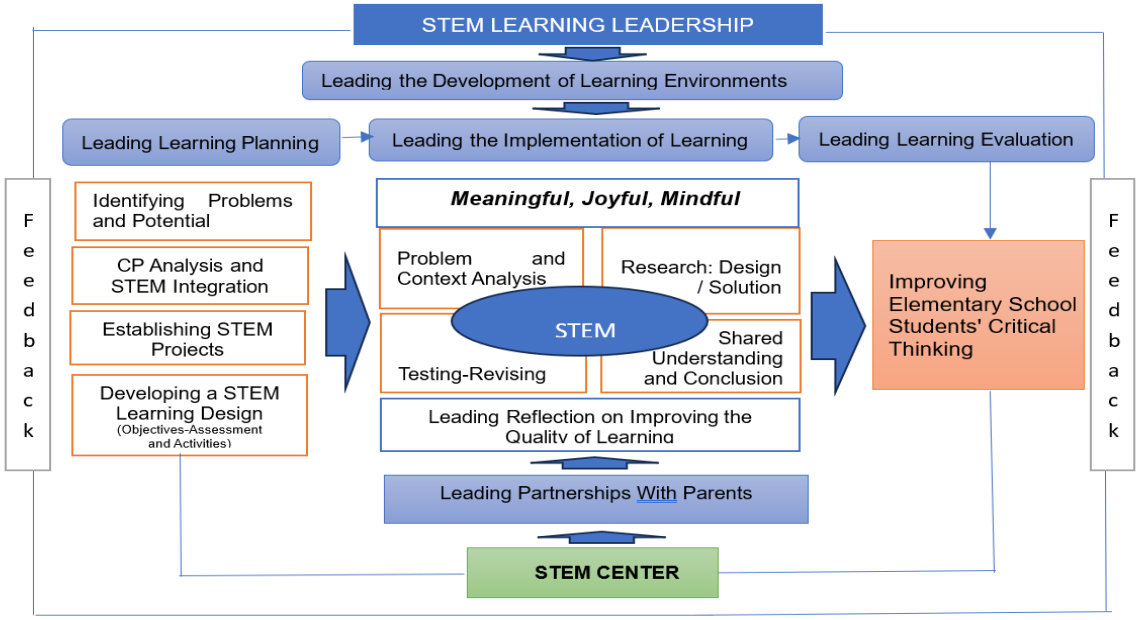


Fig. 3. Model Kepemimpinan Pembelajaran Berbasis STEM

The STEM-Based Learning Leadership Model developed in this study underwent several revisions based on expert validation and practitioner feedback. The final model consists of the following components and aspects:

1. Leading the Development of a Student-Centered Learning Environment
   School leaders are responsible for creating and fostering a learning environment that places students at the center of the learning process, encouraging active engagement, collaboration, and meaningful learning experiences.
2. Leading Learning Planning, which includes:
   a) Identifying School Characteristics, Problems, and Potentials. These three aspects provide a comprehensive understanding of the school context. The results of the identification process are analyzed and prioritized to determine the key challenges and potentials that need to be addressed and developed.
   b) Analyzing Learning Outcomes and Integrating STEM Components into Subject Content. This process ensures alignment between curriculum objectives, STEM components, and subject matter.
   c) Determining STEM Project Topics. Project topics are selected based on the results of the identification process and the analysis of learning outcomes.
   d) Designing STEM Learning. This stage involves establishing learning objectives, assessment strategies, and instructional procedures while incorporating scientific and engineering practices. Learning objectives are derived from the analysis of learning outcomes and selected projects. Assessment strategies are aligned with the intended learning objectives. The instructional design consists of four learning stages.
3. Leading Learning Implementation
   The implementation process integrates the principles of Deep Learning *Meaningful, Joyful, and Mindful Learning* with the core principles of STEM education, namely problem-solving, scientific and engineering practices, and interdisciplinary integration. Learning activities emphasize responsible and conscious problem-solving, focusing on authentic issues that are relevant and beneficial to the community in which students live. Scientific and engineering practices are conducted in a meaningful and enjoyable manner, enabling students to develop self-regulation and recognize the relevance of what they learn to everyday life. The learning process follows four stages:
   a) Analysis of problems and potentials
   b) Investigation and solution design
   c) Testing and revision; and
   d) Shared understanding and conclusion
4. Leading Reflection to Improve Learning Quality
   School leaders facilitate reflective practices among teachers and students to continuously improve the quality of teaching and learning processes.
5. Leading Parent Partnerships
   Parents are encouraged to participate directly as learning resources and mentors or indirectly by providing support for students' learning activities.
6. Leading the Evaluation of STEM Learning Programs
   School leaders evaluate STEM learning programs to determine their effectiveness in improving elementary school students' critical thinking skills. This evaluation can be conducted through the analysis of students' summative assessment results and other relevant performance indicators.
7. Establishing a School STEM Center
   A STEM Center is established within the school as a professional learning community that supports teacher professional development, collaboration, innovation, and the continuous improvement of student learning quality.

The developed STEM-Based Instructional Leadership Model is strengthened by six main, interrelated components. First, student-centered learning positions students as active agents in constructing their knowledge and learning experiences [21]. Second, the principle of deep learning comprising meaningful, mindful, and joyful learning aims to foster deep conceptual understanding that is reflective and meaningful [21]. Third, STEM learning characteristics emphasize problem-solving, scientific and engineering practices, and interdisciplinary integration to develop students' critical thinking and creativity skills [22]. Fourth, learning leadership plays a role in directing, facilitating, monitoring, and continuously evaluating the learning process to improve student learning quality [23]. Fifth, parental partnership provides support for the learning process both as a learning resource and as a companion in project-based activities, making learning more contextual. Sixth, the establishment of a STEM Center serves as a professional learning community that supports teacher collaboration, competency development, and the sustainability of instructional innovation in schools [24]. The integration of all these components forms a learning ecosystem that supports the implementation of STEM based on deep learning to enhance the critical thinking skills of elementary school students.

Implementation and Evaluation. The practicality test conducted by a panel of experts and practitioners indicated that the STEM-Based Learning Leadership Model was categorized as highly feasible, achieving an average feasibility score of 85.68%. This result suggests that the developed model possesses a high level of practicality, making it easy to understand and implement within elementary school settings. According to Nieveen, the quality of an educational model is determined by three main criteria: validity, practicality, and effectiveness [25]. During the implementation phase, the response from school principals as the primary users of the model reached 84.97%, which was categorized as very satisfactory. This high level of user satisfaction indicates that the model provides clear guidance for implementing STEM-based learning leadership practices. User acceptance is considered one of the key indicators of the successful implementation of an educational innovation [26]. The implementation results also revealed that learning leadership plays a significant role in improving the quality of the teaching and learning process. Effective learning leadership focuses on developing an academic vision, supporting teachers, and continuously monitoring instructional practices [27]. Within the developed model, school principal function as facilitators who support the implementation of STEM learning, thereby fostering a more innovative and student-center learning environment. The integration of STEM learning within the model supports the development of twenty-first-century skills, including critical thinking, creativity, collaboration, and problem-solving. Integrated STEM learning enables students to connect concepts from multiple disciplines to address real-world problems effectively [28]. Therefore, the developed model contributes not only to improving the quality of instruction but also to enhancing students' competencies required for future challenges. However, the model can still be further refined through strengthening teachers' STEM-related competencies, optimizing the role of the STEM Center, and enhancing partnerships with parents and the broader community. Continuous improvement is essential to ensure that educational innovations remain relevant to evolving school needs and societal changes[29].

Conclusion

A STEM-based learning leadership model is urgently needed in elementary schools. This model serves as a guide for leading learning management, adhering to the principles of deep learning and STEM learning. The STEM-based learning leadership model consists of seven components: Component 1) Leading the Development of a Student-Oriented Learning Environment; 2) Leading learning planning; 3) Leading learning implementation; 4) Leading reflection to improve the quality of learning; 5) Leading partnerships with parents; 6) Leading evaluation of STEM learning; 7) Leading STEM centers as part of a learning community for professional development and improving the quality of student learning. Each component has its own aspects.

Recommendation: The model can be implemented by principals or teachers and can be further developed for further research by integrating digital media such as robotics and AI.

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E-Learning

Who Gets to Generate Knowledge: Co-creation of an "Open Educational Resources" Textbook

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Abstract

Open Educational Resources (OER) have become indispensable in higher education as mechanisms for improving access, availability concerns, rising costs, inequities embedded in commercial textbooks. While significant literature has documented OER adoption/adaptation as cost saving, less attention has been given to faculty-driven knowledge creation, underlying open textbook development. This case study documented the collaborative process of five faculty engaged in developing an OER textbook for graduate-level educational research students. Based on Nonaka and Takeuchi's SECI model of knowledge creation, the process involved faculty moving from shared tacit knowledge to explicit knowledge, creating an openly licensed textbook, through socialization, externalization, combination, and internalization. Multiple data sources included shared planning documents, draft chapters, and reflective notes generated throughout the process, and prolonged engagement. The initial data analysis yielded four interrelated themes: 1) shared dissatisfaction with commercial textbooks as an agent for collaboration; 2) negotiation of disciplinary and pedagogical assumptions; 3) emergence of collective pedagogical ownership; and 4) conceptualization of the open textbook as a living, revisable product of knowledge. The subsequent data analysis revealed the alignment of four themes with the SECI model of knowledge creation, demonstrating how faculty engaged in a sustained sense-making process and professional learning rather than discrete content production. To conclude, apart from providing students with a freely accessible open textbook, the study was consistent with the OER literature in that the process promoted curricular coherence, strengthened collective pedagogical ownership, and supported sustainable engagement with open pedagogy. The study suggests that OER development provides a scalable, low-risk entry point for faculty participation in open knowledge practices while cultivating institutional cultures of collaboration and equity.

Keywords: *Collaborative process; explicit knowledge; Open Educational Resources; tacit knowledge; SECI model*

1. Introduction

Rising commercial textbook costs continue to pose a significant barrier to student access and success in higher education, particularly for students from historically marginalized and economically vulnerable populations [1,2]. Open Educational Resources (OER), defined as teaching, learning, and research materials which reside in the public domain or are released under an open license, have emerged as a promising alternative addressing both cost and access concerns [3,4]. Research consistently demonstrates that OER adoption reduces financial barriers without diminishing learning outcomes [5–7]. Beyond cost savings, scholars argue that OER challenge traditional models of knowledge ownership by repositioning faculty and learners as contributors to shared knowledge ecosystems [8,9]. Despite this potential, most OER research emphasizes adoption/adaptation outcomes rather than the collaborative processes through which open educational content is created. Less attention has been given to the internal processes through which faculty collaboratively create open textbooks and how such processes shape professional learning, curriculum design, and shared ownership of knowledge. Addressing this gap was essential for understanding how OER initiatives could be sustained as scholarly and pedagogical practices rather than one-time reductions in cost.

The aim of this study was to deepen understanding of the collaborative process of open textbook development and to confirm previous findings. The collaboration focused on the social, relational, and epistemological dimensions of OER development which involved five faculty, situated within a graduate program in college of education. The vision was to respond to the gaps in learning objectives and pedagogical needs as well as release students from a financial burden. The research question which guided the study was: How do faculty collaboratively create an open textbook, and how can this process be understood through the SECI model of knowledge creation?

2. Literature Review

Open Educational Resources are described as educational materials that are freely accessible and openly licensed, permitting use, adaptation, and redistribution with limited restrictions [3]. Open licensing, most commonly through *Creative Commons*, enables what Wiley [4] describes as the 5R permissions: *retain*, *reuse*, *revise*, *remix*, and *redistribute*. These permissions distinguish OER from merely *free* resources by granting legal authority to adapt content for local contexts. A substantial body of literature documents the impact of OER on affordability and access. OER adoption has been associated with comparable or improved learning outcomes while easing the financial burden [5-7]. Studies show that high textbook costs influence enrollment decisions, persistence, and academic performance [1,10]. In addition, OER have been framed as a social justice intervention. Equity-oriented outcomes depend on who creates OER and how knowledge is negotiated during development. Lambert argues that openness must be understood not only in economic terms but also as a mechanism for redistributing *epistemic power* and *representation* [11]. Open pedagogy extends OER principles into teaching practices that emphasize collaboration, transparency, and participatory knowledge creation [12,13]. Practices such as renewable assignments and open publishing position faculty and students as co-creators rather than consumers of content [14].
While student co-creation has received significant attention, faculty-to-faculty collaborative knowledge creation remains underexamined. Although faculty awareness of OER is increasing, participation in OER creation remains limited due to time constraints, lack of incentives, and uncertainty around quality and sustainability [15,16]. Research which examines faculty-created OER highlights professional learning, shared ownership, and curricular coherence as key outcomes [17,18]. However, few studies offer a theoretical explanation of *how* faculty knowledge based on personal experience is transformed into shared, open curricular resources.

2.1 Theoretical Framework: SECI Model of Knowledge Creation

Nonaka and Takeuchi's SECI model of knowledge creation became the foundation of the OER co-creation as the process involved shared knowledge building and collaboration. The model illustrated the dynamic interaction between tacit and explicit knowledge by means of four iterative processes: **S**ocialization, **E**xternalization, **C**ombination, and **I**nternalization [19, 20]. The model has been applied widely in organizational learning and professional development contexts to explain how individual expertise becomes shared knowledge [20]. Recent research has extended the SECI model into educational settings, including collaborative curriculum design and creativity-focused learning environments [21,22]. The alignment between SECI and open pedagogy lies in their shared emphasis on interaction, reflection, and collective meaning-making. In this study, the SECI model served as an analytic lens for understanding the collaboration of creating an OER. Faculty's *tacit knowledge*, personal experience, observations, intuition, became the starting point of the collaborative process, and the end result was *explicit knowledge* which was documented, stored and shared knowledge. [19, 20].
The following diagram (Fig. 1.) illustrates the conceptual relationship among: Open Educational Resources; Open Pedagogy; and the SECI Model of Knowledge Creation.

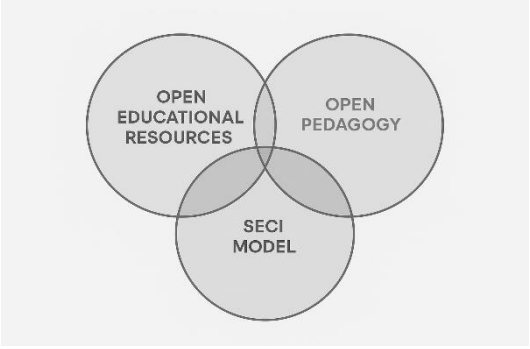


Fig. 1. Conceptual relationship among Open Educational Resources, Open Pedagogy, SECI Model

According to the conceptual relationship, the circle entitled *Open Educational Resources* represents the material and licensing foundation of openness which is the 5R permissions (retain, reuse, revise, remix, redistribute); and access, adaptability, and sustainability [4] which depends on OER adoption or OER creation. The *Open Pedagogy* circle represents the teaching and learning practices enabled by OER

which is collaborative knowledge and production; faculty and possibly, students as co-creators; renewable and participatory assignments. The SECI Model [19, 20], the third circle, demonstrates the theoretical framework, representing the knowledge creation process which explains how openness works in practice and is illustrated as four iterative processes: 1) *Socialization* (faculty sharing tacit knowledge); 2) *Externalization* (articulating ideas into chapters and outcomes); 3) *Combination* (integrating content into a coherent textbook); and 4) *Internalization* (using, teaching with, and revising the OER). Moreover, regarding the conceptual relationship, the center overlap represents the intersection of all three constructs symbolizing faculty-driven open textbook development as a knowledge-creation activity; a form of open pedagogical practice; and structural and legal OER permissions.

Building on OER, open pedagogy, and knowledge creation literature, this study aimed to contribute to a theoretically grounded examination of faculty-driven open textbook development. By applying the SECI model of knowledge creation [19, 20] to a collaborative OER project, the study focused on the social and epistemic dimensions of open knowledge production. In addition, the study demonstrated the understanding of how faculty collectively generate, structure, and internalize OER.

3. Methodology

Employing a case study design, the study explored a collaboration process within a bounded institutional context [23, 24]. The research question which guided the study was: How do faculty collaboratively create an open textbook, and how can this process be understood through the SECI model of knowledge creation? The collaboration process focused on the social, relational, and epistemological dimensions of OER development and involved five faculty members teaching graduate-level educational research courses. One of the faculty members, also the author, collected and analyzed the textual data related to the phenomenon which included shared planning documents, draft chapters, and reflective notes generated throughout the project and prolonged engagement. The linguistics and research background of the author allowed the completion of the thematic analysis. The *analytic memos* [25] kept during the analyses also helped further to strengthen the findings. The data were analyzed in two phases. The initial phase yielded four interrelated themes, consistent with OER research. The subsequent analysis involved interpreting the findings through the four phases of the SECI model to further understand the collaborative process. Findings were verified by *member checking.* Trustworthiness of the study was enhanced by *triangulation* based on multiple data sources [26, 27].

3.1 Data Analysis: Two Phases

The first phase of the data analysis, the initial analytic phase, employed an iterative thematic approach [28] by means of the *Key-word-in-context (KWIC) method* [29] to inductively identify related words/phrases across collected data which included shared planning documents, draft chapters, and reflective notes to remain grounded in faculty language and experiences. Following the identification of the related key words/phrases in the texts, the author manually coded the recurring concerns, points of negotiation, and moments of shared decision-making during the prolonged engagement of faculty collaboration and pedagogical sense-making. *Values coding* was selected since the data included the *interplay between/among thoughts, feelings and action* and made it possible to interpret the faculty *values, attitudes and beliefs* during the process [25]. *Analytic memos* [25] generated by the author throughout the analytic phases, further documented emerging interpretations, tensions, and shifts in understanding the themes [29]. Through constant comparison, codes were clustered into categories leading to broader themes which reflected patterns of collaboration. As a result, the open textbook development revealed four interrelated themes characterizing: 1) shared dissatisfaction with commercial textbooks as an agent for collaboration; 2) negotiation of disciplinary and pedagogical assumptions; 3) emergence of collective pedagogical ownership; and 4) conceptualization of the open textbook as a living, revisable knowledge artifact.

Following the initial analytic phase, the subsequent analytic phase involved contextualizing the four themes within the process of the SECI model of knowledge creation in order to examine how faculty moved between tacit and explicit knowledge during this open textbook development. A*nalytic memos* also helped link each theme to the corresponding SECI phase. This process was also completed manually by juxtaposing the key words in the themes to the description of the SECI model phases including socialization, externalization, combination, and internalization.

4. Findings

The development of an open textbook functioned as a collaborative knowledge-creation process rather than a linear authorship task. The five-faculty engaged in a collaborative process to transform tacit pedagogical expertise into explicit, openly licensed curricular knowledge through sustained interaction. The group did not simply divide writing tasks; rather, engaged in collective sense-making as they showed their tacit instructional knowledge, articulated shared assumptions about educational research, and iteratively refined their perspectives through dialogue and co-authorship. Consistent with the SECI model of knowledge creation, this process involved dynamic movement between tacit and explicit knowledge as faculty socialized professional experiences, externalized implicit understandings into curricular structures, combined individual contributions into a coherent open textbook, and internalized the resulting resource through classroom use and revision [21].

The codes and categories leading to the four interrelated themes emerged prior to mapping the SECI phases and were characterized as follows: 1) The first insight was that *faculty frustration* functioned as *productive tension* that initiated the collaboration. The *shared dissatisfaction* of faculty emerged from codes such as thoughts and feelings of *frustration*, *textbook misalignment*, *cost concerns*, *student confusion*, *teaching around the commercial textbook*. These codes led to theme one: *shared dissatisfaction as an agent for faculty collaboration*. 2) The second insight was that knowledge creation required surfacing of *implicit epistemological commitments*. Codes included *what counts as research*, *student needs*, *values of learning, methods hierarchy*, *curriculum disagreements.* These codes led to theme two: *Negotiation of disciplinary and pedagogical assumptions*. 3) The third insight was that authorship shifted from individual contribution to collective responsibility. Codes included key phrases such as *we language, shared outcomes, alignment across sections, and editing each other's work.* These codes led to theme three: *Emergence of collective pedagogical ownership*. 4) The fourth insight was that the textbook was understood as a process, not a finished product. Codes included: *future revisions, classroom feedback, adaptability, open licensing affordances, living materials*. These codes led to theme four: *Open textbook as a living, revisable knowledge artifact*.

To further explicate how these themes functioned as knowledge creation, the initial four findings were interpreted using the SECI model as part of the subsequent data analytics. The SECI framework provided an explanatory structure for understanding how the identified themes unfolded through cycles of *socialization*, *externalization*, *combination*, and *internalization*. This process highlighted how faculty collaboration process functioned as the primary mechanism through which open knowledge was generated, legitimized, and sustained [19]. The four themes aligned closely with the SECI model, and reflected how faculty engaged in sustained sense-making and professional learning rather than discrete content production as follows: 1) *Socialization: Sharing Tacit Pedagogical Knowledge*. The inductive theme, *shared dissatisfaction*, was visible during this phase. Faculty shared experiential knowledge regarding teaching challenges and disciplinary assumptions through dialogue and reflection. The project began with faculty conversations centered on *shared dissatisfaction* with the existing commercial textbooks. Through dialogue, participants exchanged tacit knowledge regarding individual teaching philosophies, recurring student difficulties, and implicit assumptions about graduate level educational research. These conversations established a shared problem space and created conditions for mutual trust and intellectual risk-taking. While the creation of content was a shared responsibility, the division of labor included a designated lead author/editor responsible for process monitoring. The lead editor acted as the *metacognitive anchor*, ensuring that individual chapters/sections remained aligned with the overarching learning objectives and the final synthesis met rigorous graduate-level standards. Moreover, during this phase, the group selected a user-friendly platform, *Pressbooks,* to create their digital book which allowed simultaneous editing and version control [30, 31]. 2) *Externalization: Articulating Implicit Understandings.* The *negotiations of assumptions* theme was visible in the *externalization* phase. Implicit understandings were articulated into learning outcomes, chapter structures, and pedagogical features through collaborative planning [20]. As discussions progressed, faculty began externalizing tacit insights into explicit forms, including learning objectives, organizing frameworks, and pedagogical features. Negotiating shared language required making underlying epistemological assumptions visible, thereby transforming personal teaching knowledge into collectively owned conceptual structures. 3) *Combination: Systematizing Explicit Knowledge*. The *collective ownership* theme was visible in this phase. Individual contributions were integrated into a coherent textbook structure aligned with program outcomes and supported by open publishing infrastructure [30]. Explicit contributions were integrated into a coherent textbook structure aligned with program outcomes. Following the draft textbook completion, faculty collaboratively refined chapter organization, standardized terminology, and incorporated reflective and applied learning features to support iterative

authorship, accessibility, open licensing. Finalized textbook was peer-reviewed by two external faculty. Once the textbook was approved and passed the review phase, it was added to the university scholarship repository to be accessed freely by students. 4) *Internalization: Teaching, Using, and Revising*. The *living textbook* theme was visible in this phase for faculty internalized the shared knowledge through classroom implementation, revision, and ongoing use [19]. The textbook also became freely available in the *Open Textbook Library* repository for adoption or adaptation by other institutions. Classroom use prompted further reflection and revision, allowing explicit knowledge embedded in the textbook to be reinternalized through instructional practice. This ongoing cycle reinforced shared pedagogical commitments and positioned the textbook as a living curricular resource rather than a static product.

5. Conclusion and Implications

This study examined faculty-driven OER textbook development through the lens of the SECI model of knowledge creation, foregrounding collaboration as the central mechanism through which open knowledge was generated. Rather than conceptualizing open textbook creation as a linear authorship task, the findings demonstrated that the process functioned as a dynamic cycle of collective inquiry in which faculty socialized tacit pedagogical expertise, externalized shared assumptions, combined explicit contributions into a coherent curricular resource, and internalized the resulting knowledge through teaching and iterative revision. These findings extend the existing OER literature by shifting analytic focus from adoption outcomes and cost savings to the *epistemic labor* of open textbook creation. While prior research has emphasized the economic and access-related benefits of OER [6-9], this study demonstrated that faculty-created OER textbooks also operate as sites of professional learning, curricular alignment, and shared meaning-making [30, 32]. In this sense, open textbook development aligns closely with principles of open pedagogy, not merely because of open licensing but because of the collaborative processes through which knowledge is negotiated and legitimized [12–15]. Applying the SECI model provides an explanatory framework for understanding how faculty expertise becomes institutional knowledge. The iterative movement between tacit and explicit knowledge observed in this study reflects findings from organizational learning research while extending them into the domain of higher education curriculum design [17-22]. Importantly, the SECI framework highlights that openness alone does not produce knowledge; rather, it is the structured interaction among participants that enables transformation of individual insight into shared, sustainable resources.

5.1 Implications for Students

Faculty-created open textbooks based on empiricism can eliminate certain barriers present for students which come with commercial textbooks. These freely available resources can provide access to materials, eliminate restricted availability, address rising textbook costs, and improve inequities. Eliminating such barriers can also affect retention, and serve as a marketing tool for recruitment.

5.2 Implications for Faculty, Researchers and Institutions

The findings also suggest that open textbook development can serve as a meaningful form of scholarly and pedagogical engagement. Collaborative OER creation offers opportunities for reflective practice, disciplinary dialogue, and alignment across multi-section courses; outcomes that are often difficult to achieve through isolated course design. Framing open textbook work as collective inquiry rather than content production may also lower perceived barriers to participation by emphasizing learning and shared ownership over technical expertise [22].
To conclude, faculty-created open textbooks [30, 32] represent more than alternatives to commercial content; these digital sources embody a reconfiguration of how academic knowledge is generated, shared, and sustained. By framing open textbook development through the SECI model, this study demonstrates that collaborative knowledge creation lies at the heart of open education practice. Supporting such processes may enable institutions to move beyond adoption toward more equitable, participatory, and sustainable cultures of openness in higher education.

6. Limitations and Future Directions

While this study focused on a single case within one institutional context, its purpose was analytic rather than generalizable in a statistical sense.

Future research could extend this work through comparative studies, longitudinal designs, or mixed-methods approaches examining learning outcomes alongside faculty experiences. Additional inquiry is also needed to explore how power, positionality, and institutional reward structures shape participation in open knowledge creation. Furthermore, future research might examine how SECI-informed collaboration unfolds across disciplinary contexts, includes students as knowledge co-creators, or evolves over multiple revision cycles of open textbooks.

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From Engagement Trajectories to Targeted Support: An Intervention-Oriented Framework for Reducing Learning Gaps in MOOCs

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Abstract

Massive Open Online Courses (MOOCs) expand access to learning, but instructors and platforms often struggle to translate noisy and sparse engagement traces into timely support that is both pedagogically meaningful and feasible to deliver at scale. This paper proposes a three-stage, workload-aware intervention framework that bridges early-warning evidence in learner traces and course-level decision making. Stage 1 derives interpretable signals from engagement trajectories and assessment participation (e.g., inactivity accumulation, engagement variability, and assessment-to-content imbalance). Stage 2 maps these signals into risk archetypes using transparent, educator-auditable rules that resolve conflicting evidence and prioritize actionable explanations (e.g., early disengagers, deadline-driven cramming, irregular persistence, and assessment-dominant strategies). Stage 3 operationalizes archetypes under capacity constraints by selecting intervention policies that explicitly balance anticipated instructional value against available instructional resources, enabling graduated support (universal low-intensity supports plus budgeted, targeted higher-intensity supports when risk persists). We use the public HarvardX–MITx Person–Course Academic Year 2013 dataset as a motivating context and describe a filtered working sample of 338,223 person-course records from that release to illustrate the scale and structural sparsity of MOOC learner data, motivating budgeted, stage-specific interventions rather than blanket "at-risk" labeling. The contribution is a practitioner-oriented blueprint for designing interventions that remain faithful to evidence in learner traces while acknowledging the operational realities of large-scale online education.

Keywords: *MOOCs, learning gaps, engagement trajectories, targeted support, capacity-aware interventions*

1. Introduction

MOOCs have enabled wide participation in higher education and professional upskilling, but high dropout rates and persistent learning gaps remain common. In this paper, we use learning gaps broadly to mean emerging differences in learners' ability to sustain participation, access core course activities, and progress toward successful completion. Foundational MOOC studies documented substantial heterogeneity in how learners engage with course content and assessments, including early disengagement and irregular participation patterns [1,2]. More recent work has emphasized that early-course behavior can be predictive of later success or dropout risk [3,4]. In parallel, the learning analytics community has produced a rich set of methods for profiling learners and predicting outcomes using platform traces [5,6]. Despite these advances, the practical adoption barrier often lies in the step after prediction: translating analytics into timely, feasible, and pedagogically meaningful actions. Instructors and course teams need to decide (i) which engagement signals should trigger a response, (ii) what kind of support is appropriate for a given behavioral pattern, and (iii) how to prioritize interventions under limited capacity. To address this gap, we reframe early warning as an intervention design problem and contribute an intervention-oriented framework that converts interpretable engagement-trajectory signals into actionable support policies. The framework builds on our prior empirical work, which identified these signals through hybrid-weighted clustering and anomaly analysis on the same MOOC release. This paper does not evaluate predictive accuracy or intervention effects. Instead, it presents a rule-based framework for translating learner-trace evidence into feasible support decisions.

The paper makes three contributions: (1) a compact set of trajectory signals intended for intervention triggering (Table 1), (2) an interpretable set of risk archetypes and a corresponding intervention playbook (Table 3), and (3) a workload-aware evaluation perspective that accounts for the number of learners targeted each week (Table 4). Figure 1 summarises the overall pipeline. The intended audience is course teams and platform operators who already have access to learning analytics dashboards but

lack a structured way of converting their outputs into bounded, repeatable instructional actions. We therefore prioritise interpretability, low implementation cost, and the ability for an instructor to inspect why a particular learner was flagged. Throughout the paper, the HarvardX-MITx Person-Course dataset serves as descriptive context for the scale and sparsity challenges of MOOC support. It is not used as an evaluation benchmark, because our contribution is a design framework, not a predictive model.

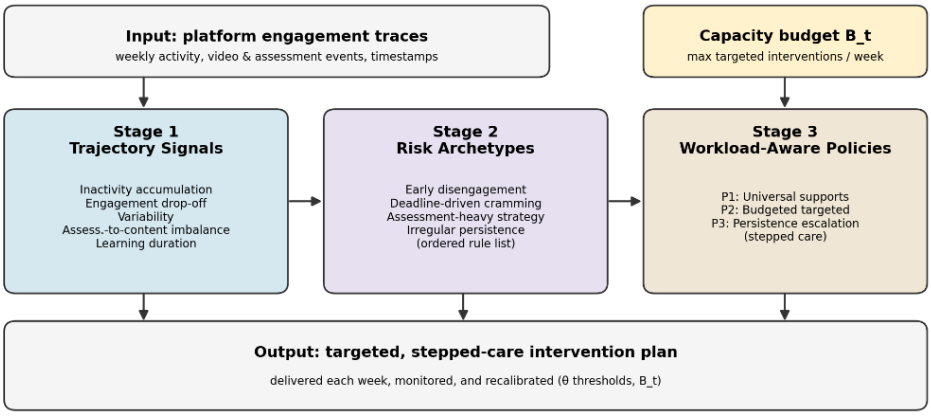


Fig. 1. Three-stage intervention-oriented framework. Engagement traces feed Stage 1 signal extraction, Stage 2 maps signals to interpretable risk archetypes, Stage 3 selects graduated-support policies under a weekly capacity budget B_t.

2. Related Work

Early MOOC research highlighted engagement diversity and the need to interpret learner behavior beyond completion rates [1,2]. Broader reviews of MOOC research also show that engagement, retention, learner motivation, and course design remain recurring concerns across the field [7]. Work on engagement subpopulations introduced typologies that distinguish disengaged, auditing, and completing behaviors [2], while dropout prediction studies established that early-week traces can provide useful signals for risk detection [4,8]. Beyond dropout, performance prediction and certification prediction have been explored using prior knowledge, activity traces, temporal features, and interpretable feature sets [3,9]. However, there is a well-known gap between analytics outputs and actionable instructional decisions. Surveys of educational data mining and learning analytics emphasize the importance of aligning models with educational objectives and interpretability requirements [5,6]. Recent systematic reviews also summarize the multi-factor nature of MOOC engagement and dropout, pointing to the importance of contextual and motivational explanations [10]. Motivations and challenges reported by learners and instructors further suggest that interventions should support pacing and reduce friction during critical attrition windows [11].

This paper builds on that line of work by organizing engagement-trajectory evidence into a framework that is explicitly optimized for intervention decisions. Our emphasis is on (i) interpretability of signals and (ii) operational feasibility of responses at MOOC scale. It also builds directly on our prior empirical work on MOOC learning-gap detection [12]. That work examined hybrid-weighted K-Means, OPTICS, and Local Outlier Factor on the HarvardX-MITx Person-Course release, identified engagement signals, such as quiz-to-video ratio, inactive weeks, engagement variability, and engagement slope, that separate learners into clusters with distinct underperformance rates, and analysed clustering failure modes that produce technically valid but outcome-flat partitions. The present paper extends that empirical line of work by translating the previously identified engagement signals into an educator-auditable, workload-aware intervention framework. It serves as the design-and-deployment counterpart to the earlier learner-segmentation analysis.

3. An Intervention-Oriented Framework

The framework proceeds in three stages: (1) compute interpretable trajectory signals, (2) map signal combinations to intervention-ready risk archetypes, and (3) select interventions using workload-aware policies. The framework is designed so that each stage can be implemented by course teams without specialized machine learning infrastructure.

3.1 Stage 1: Trajectory Signal Extraction

Instead of relying solely on aggregate activity counts, we focus on trajectory signals that capture engagement shape over time. Temporal analyses of MOOC study patterns have shown that the timing and regularity of activity can differentiate meaningful behaviors even when total engagement volume is similar [13]. Table 1 lists the proposed signal set.

Table 1. Intervention-oriented engagement trajectory signals.

Signal	Operational definition (example)	Intervention rationale
Inactivity accumulation	Count of course weeks with no recorded events up to week t	Directly indicates disengagement windows, commonly predictive early in a course [4,8].
Engagement drop-off	Ratio of mean engagement in recent weeks vs. initial weeks (e.g., weeks 1-2)	Detects loss of momentum after initial onboarding, supports timely re-engagement prompts [2,11].
Engagement variability	Dispersion of weekly engagement (e.g., standard deviation over weeks 1..t)	High variability can indicate unstable study routines or deadline-driven activity, requiring pacing scaffolds [13,14].
Assessment-to-content imbalance	Smoothed quiz-to-video ratio or related proxy of assessment-first strategies	Flags potentially shallow strategies and test-taking behavior, suggests adaptive review or concept-check follow-up [9,15].
Learning duration	Time span between first and last recorded activity (within the course window)	Supports distinguishing early dropouts from late disengagers, informs when interventions may still help [1,10].

3.2 Stage 2: Risk Archetypes

Stage 2 translates the signal set from Stage 1 into a small number of intervention-ready risk archetypes. The aim is not to discover clusters, but to produce labels that are (i) interpretable, (ii) stable enough for operational use, and (iii) directly connected to a plausible instructional response. Each archetype specifies: (1) a signal pattern (expressed as simple conditions on Table 1 signals), (2) a likely barrier or learning-gap mechanism, and (3) a recommended first-line action from the intervention playbook (Table 3). Archetypes are therefore designed as interpretable support categories rather than statistical groupings.

Rule template. Let S(t) be the vector of signals from Table 1 computed up to week t for a learner. An archetype a is defined by a Boolean rule f_a(S(t)) that returns TRUE when the observed early trajectory matches the archetype pattern. If no rule fires, the learner remains unassigned and receives only universal low-intensity supports (Stage 3, Policy P1).

Conflict resolution and decision order. Multiple rules may fire simultaneously (e.g., a learner can be both highly variable and also show a strong drop-off). To ensure a single actionable label, we apply an ordered decision list that prioritizes conditions that suggest imminent disengagement and require earlier intervention. A practical default order is: (1) Early Disengagement, (2) Deadline-Driven Cramming, (3) Assessment-Dominant Strategy, and (4) Irregular Persistence.

Example ordered rules (course-calibrated thresholds θ are set from early-course distributions): (1) Early Disengagement if inactivity accumulation ≥ θ_inactive OR drop-off ratio ≤ θ_drop, (2) Deadline-Driven Cramming if engagement variability ≥ θ_var AND a late surge indicator is TRUE, (3) Assessment-Dominant Strategy if assessment-to-content imbalance ≥ θ_imbalance (assessment-dominant), (4) Irregular Persistence if engagement variability ≥ θ_var but without sustained decline, otherwise Unassigned.

These archetypes are intentionally coarse. Their purpose is to provide educators with an auditable explanation and a clear first step, not a definitive diagnosis. In deployment, thresholds and rule order can be tuned to course context, and archetype definitions can be validated by monitoring whether the corresponding interventions reduce subsequent risk signals.

3.3 Stage 3: Workload-Aware Intervention Policies

Stage 3 turns archetype labels into workload-aware intervention decisions. The key inputs are (i) the set of learners flagged at week t, (ii) the intensity and timing of available interventions, and (iii) an explicit capacity budget B_t, defined as the maximum number of targeted interventions that can be delivered in that week without overwhelming learners or staff. Budgeting is central in large-scale courses because even low-cost actions can scale to thousands of messages, and excessive targeting can reduce trust and increase opt-outs. We therefore recommend a graduated-support approach that starts with universal, low-intensity supports and escalates to higher-intensity, targeted supports only when risk persists and budget allows.

Policy families. We recommend three deployable policy types: (P1) Universal supports (e.g., pacing reminders and 'start-here' prompts) delivered to all learners, (P2) Budgeted targeted supports delivered only to the top-ranked flagged learners up to B_t (e.g., structured catch-up pathways, adaptive review prompts, or tailored remediation links matched to the archetype), and (P3) Persistence-based escalation, where learners flagged for consecutive weeks move to a higher-intensity targeted tier while one-time flags receive only P1 or light P2.

Prioritization within a budget can be implemented with a simple priority score derived from Table 1 signals (e.g., combining inactivity, drop-off ratio, and variability) and selecting the highest-scoring learners until the weekly budget is exhausted. A lightweight monitoring loop (delivery counts, opt-outs, and subsequent engagement shifts) supports recalibration of θ thresholds and B_t over time.

3.4 Deployment Considerations

The framework is intentionally designed to be implemented on top of an existing learning analytics dashboard, not as a standalone system. A minimal deployment requires three artefacts: (i) a weekly batch job that computes the Table 1 signals from platform logs, (ii) a small rule file expressing the ordered Stage 2 archetype list and the current threshold values θ, and (iii) a delivery layer that can dispatch templated messages or surface in-course banners under the Stage 3 policies P1-P3. None of these components requires model training, GPU infrastructure, or feature engineering beyond the aggregates that most MOOC platforms already expose.

In practice we recommend that course teams begin with a pilot deployment without learner-facing messages, in which signals and archetype labels are computed and logged each week. After two to three weeks of pilot data, instructors can inspect the distribution of triggered archetypes, sanity-check a small random sample of flagged learner trajectories, and tune θ and B_t before activating P1 supports. This staged roll-out is also the natural time to confirm that the rule order in Stage 2 reflects the course's pedagogical priorities, since the same signal pattern can plausibly justify more than one first-line action depending on the discipline.

4. Data Context and Implementation Requirements

We use the public HarvardX-MITx Person-Course Academic Year 2013 dataset, a de-identified dataset of learner-course records from HarvardX and MITx offerings on edX, covering Fall 2012 to Summer 2013 across 16 courses [16]. Prior analyses using this de-identified release report 641,138 person-course observations from 476,532 unique learners after aggregation [17]. For the descriptive scale-and-sparsity context used in this paper, we draw on a 338,223-record analytic subset derived from this release in our prior work [12], restricted to five selected MOOCs (CS50x, CB22x, ER22x, PH207x, and PH278x) and obtained after the study's preprocessing pipeline (exclusion of internally inconsistent records flagged in the release, zero-imputation of structural non-engagement, and removal of records not meeting the analytic inclusion criteria). Within that subset, temporal trajectory analyses focused on a single 21-week course to avoid cross-course differences in calendar length, pacing, assessment cadence, and instructional design. Because the public file contains aggregate counts and does not provide per-event timestamps, weekly activity was approximated by distributing each learner's total events across their active weeks, and computationally expensive analyses, such as DBSCAN with DTW distances, were applied to a subsample [12]. The subset is used here only as descriptive context for the scale and sparsity challenges of MOOC support design, not as a benchmark for evaluating predictive performance or intervention effects.

Initial inspection of the working sample highlights substantial structural sparsity: in our prior analysis of this subset, 90.16% of learners exhibited no recorded video interactions and 62.04% showed no activity in key course events such as problem sets and chapter interactions [12]. This matters operationally

because trace-based support rules can only act on learners for whom some behavioural evidence is available.

Table 2. Dataset context and descriptive indicators used to motivate workload-aware intervention budgeting.

Characteristic	Value	Notes
Dataset	HarvardX–MITx Person–Course Academic Year 2013	Public de-identified person–course release
Public release	641,138	Person-course observations across 476,532 learners, Fall 2012-Summer 2013
Working sample	338,223	Filtered subset used for the descriptive budgeting context in this paper
Video interactions	Substantial sparsity in video-event traces (90.16% of learners with no video interactions in prior analysis [12])	Illustrates uneven content-view traces in large MOOC data
Assessed components	Substantial sparsity in assessed-component traces (62.04% of learners with no activity in key course events [12])	Early assessed-event traces may be absent for many learners

The signals in Table 1 require timestamped or week-level platform logs in deployment (e.g., weekly activity counts, video and assessment events, and timestamps of first/last activity). The public person–course release is therefore used here to contextualize scale and structural sparsity, not to estimate all week-level trajectory features directly. These descriptive indicators are not used as performance results as they provide operational motivation for Stage 3 budgeting by quantifying how many learners may lack actionable trace evidence early in a course.

5. Intervention Playbook

Table 3 presents a practical playbook that maps archetypes to scalable interventions. The interventions are designed to be platform-feasible and to support learners during known attrition windows, particularly the early weeks of a MOOC [4,11].

Table 3. Risk archetypes and a scalable intervention playbook.

Archetype	Signal pattern (example)	Likely barrier	Scalable intervention
Early disengagement	Inactivity accumulation rises by week 2-3, engagement drop-off < 1	Onboarding friction, low self-efficacy, unclear expectations	Week-2 re-engagement nudge, ‘start-here’ guide, short diagnostic quiz with feedback, optional catch-up path
Deadline-driven cramming	High engagement variability with late spikes, drop-off after deadlines	Time management issues, reliance on last-minute study	Pacing scaffold: weekly plan and reminders, chunked deadlines, ‘two-step’ practice (preview then quiz)
Assessment-dominant strategy	High assessment-to-content imbalance (quiz-to-video ratio high)	Superficial engagement, test-taking without conceptual grounding	Adaptive review prompts after each quiz, short concept-check quizzes, concept-check items with explanations

Archetype	Signal pattern (example)	Likely barrier	Scalable intervention
Irregular persistence	Moderate engagement but high variability without sustained decline	Competing commitments, unstable routines	Routine-building nudges, flexible pacing options, goal-setting prompts, social participation suggestions

6. Workload-Aware Targeting and Evaluation

A common failure mode in practice is to deploy an early-warning rule that flags an impractically large fraction of learners, leading to interventions that are too diffuse to be meaningful. We propose evaluating intervention policies along three dimensions (Table 4): (i) lead time, (ii) targeting quality, and (iii) intervention workload.

Table 4. Workload-aware evaluation dimensions for intervention policies.

Evaluation dimension	What to measure	Why to measure
Lead time	Earliest week where a stable signal triggers (e.g., week 2 vs. week 5)	Earlier targeting enables low-cost supports before disengagement hardens [4,8].
Targeting quality	Association between triggers and later underperformance or disengagement	Ensures interventions focus on learners likely to benefit, aligning analytics with educational objectives [6,9].
Intervention workload	Proportion and count of learners triggered per week, intervention type cost	Supports feasible deployment, avoids overwhelming staff or learners, enables capacity planning.

Instructors can implement workload-aware targeting using simple budget rules (e.g., intervene on the top 10% highest-risk eligible learners each week) or graduated-support strategies (e.g., universal low-cost nudges plus targeted higher-cost supports). To make the budget intuition concrete, consider an illustrative course scenario with 30,000 enrollees. If 10% of enrollees (3,000 learners) generate sufficient early-week traces to be eligible for trajectory-based flagging, then a P2 budget of 5% of this eligible subset corresponds to 150 targeted contacts in a given week.

As a further illustration, suppose $\theta_inactive$ is calibrated so that the Early Disengagement rule fires on the top quartile of this eligible subset. Roughly 750 learners would then be candidates for P2 supports in week 2. Setting $B_t = 150$ would therefore force an explicit prioritisation step, with the remaining candidates routed to P1 universal messaging until the following week, when persistence-based escalation is re-evaluated. This kind of simple calculation is intended as a planning illustration, not an empirical performance result, and shows how analytics outputs can be translated into a delivery plan that an instructional team can execute.

7. Discussion

The framework reframes learner analytics outputs as intervention inputs. The approach supports educator trust and practical deployment by emphasizing trajectory shape signals and interpretable archetypes. The archetypes align with established observations of MOOC engagement patterns, including early disengagers and irregular participants [2,13]. Compared with prior work, our contribution is prescriptive and not descriptive. Earlier MOOC typologies [2] characterise how learners behave but stop short of mapping behaviours to instructional responses, while dropout-prediction models [4,8] estimate risk but rarely specify what to do once a learner is flagged. Our framework occupies the intermediate layer: it converts interpretable signals into a small set of support categories, each carrying a default action, constrained by an explicit workload budget so that the prescription is both pedagogically reasonable and operationally deliverable.

A deployment trial should track the three dimensions in Table 4 across at least one full course offering, examining whether the framework yields (i) earlier P1 universal supports than baseline instructor-driven interventions, (ii) improved or stable week-over-week engagement among learners receiving escalated P2/P3 support relative to a matched comparison group, and (iii) a weekly intervention workload within

the configured B_t budget. Degradation on any dimension should trigger threshold and rule-order recalibration rather than abandonment of the framework.
From a 'future of education' perspective, the primary value lies in scalable personalization: capacity-aware evaluation helps institutions plan support offerings across large cohorts and the same signal-archetype-policy pipeline can be transferred to university LMS courses, bootcamps, and corporate training where instructional capacity similarly constrains support delivery. A further implication concerns the role of the instructor. By exposing thresholds, rule order, and budgets as explicit operational parameters, the framework deliberately keeps a human in the loop: instructors can override archetype assignments, change priority order, or suspend Stage 3 escalation around exam weeks. We see this transparency as a precondition for responsible adoption in publicly funded courses, where learners and regulators may legitimately ask why a particular support was offered.

8. Limitations And Ethical Considerations

Several limitations should be considered before deployment. First, engagement traces are imperfect proxies for learning and may miss off-platform study, peer discussion, or use of external materials. Archetype labels should therefore be treated as conversation starters with learners, not as diagnoses. Second, signal thresholds θ are course-dependent and assume that early-course distributions are stable enough to calibrate against. In courses with very small early enrolment or highly skewed cohorts, calibration may be unreliable, and instructor review is essential before rule activation. Third, the framework itself has not yet been validated experimentally. We propose archetypes and a playbook on the basis of prior literature and dataset descriptive evidence, but we do not show that the resulting interventions improve learning outcomes. A field trial measuring learning gains, retention, and learner experience under different intervention budgets is the natural next step. Fourth, interventions can have unintended consequences. Excessive nudging may produce notification fatigue, opt-outs, or stigma effects, particularly when learners infer that they have been singled out as 'at risk'. Graduated-support escalation and explicit learner-facing explanations are intended to mitigate these effects but do not eliminate them. Fifth, the public HarvardX-MITx Person-Course release reflects MOOC behaviour from the 2012-2013 academic year. Modern platforms (current Coursera, edX, FutureLearn) differ in structure, mobile-first interaction, and learner demographics, so transferability of specific thresholds should not be assumed without recalibration. Sixth, privacy and transparency are essential when learner data drive personalised messaging. Deployments should follow responsible data practices [18], including clear opt-out mechanisms and learner-facing explanations of why support was offered. Relatedly, although prior empirical work [12] included demographic variables (e.g. age, gender, education) for explanatory analysis, the intervention rules proposed here should rely on behavioural engagement signals rather than protected or sensitive learner attributes unless their use is explicitly justified, audited, and ethically approved.

9. Conclusion and Future Work

This paper presented an intervention-oriented framework that maps interpretable engagement-trajectory signals into actionable, scalable support strategies for MOOCs. By combining a compact signal set (Table 1), intervention-ready archetypes (Table 3), and workload-aware evaluation (Table 4), the framework offers a practical bridge between learning analytics and course design decisions. The framework is intended as a design and implementation aid, not as an intervention-effectiveness study, and its next step is empirical validation through field deployment.
Several extensions follow naturally. The most important is empirical validation through a controlled or quasi-experimental field study in which Stage 3 policies are activated in one course offering and compared against an instructor-driven baseline along the dimensions in Table 4. A second extension is to broaden the rule library beyond the four archetypes described here for project-based, group-assessed, or self-paced certification tracks where engagement rhythms differ from cohort-based MOOCs. A third is to integrate the framework with adaptive content systems so Stage 3 actions can include lightweight content adjustments such as alternate pathways or scaffolded retrieval-practice items. On the methodological side, future work should investigate principled ways of setting and updating the thresholds θ and the weekly budget B_t, for example by treating threshold calibration as a constrained optimisation problem where the objective is week-level intervention precision under a hard cap on instructional cost. Rule order may also need to shift across the course timeline, and learner-facing transparency mechanisms should be designed and tested as part of the intervention bundle from the start, instead of being added only after deployment.

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AI-Powered Chatbot Assessments in Online Anatomy & Physiology: An Exploratory Mixed-Methods Pilot Study

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Abstract

As online health sciences education expands, concerns continue regarding whether traditional exam-based assessments adequately capture applied understanding, communication skills, and clinical reasoning. This exploratory mixed-methods pilot study examined the use of AI-powered chatbot assessments as an alternative to traditional high-stakes exams in two fully online Anatomy and Physiology I course sections at a community college. The sections followed identical learning objectives and instructional designs but differed in lecture assessment format: one used traditional proctored exams, while the other used structured, proctored AI chatbot conversations simulating virtual patient interactions. Quantitative survey data collected at multiple points examined student confidence, perceived learning, fairness, and assessment-related anxiety, while qualitative open-ended responses explored students' experiences with explanation, application, communication, and engagement. Because survey-response counts were small and unequal and responses were not longitudinally matched, quantitative findings were treated only as descriptive context. Qualitative responses from the AI-supported section emphasized explaining concepts in students' own words, applying anatomical and physiological knowledge, communicating in patient-friendly language, and, for some respondents, experiencing the format as less anxiety-provoking. Students also described challenges associated with learning how to interact effectively with the chatbot. These themes are consistent with constructivist learning theory and cognitive load theory and suggest that conversational AI assessments warrant further investigation as a way to capture forms of applied understanding not easily measured through traditional exams. The findings are preliminary and hypothesis-generating rather than evidence of comparative effectiveness. This study contributes preliminary classroom-based evidence to ongoing discussions about the ethical, equitable, and pedagogically sound integration of AI into online assessments.

Keywords: *artificial intelligence, assessment, anatomy and physiology, online learning, mixed methods*

Introduction

Assessment practices in higher education, particularly in foundational and gateway health science courses, have continued to rely heavily on traditional measures of student learning even as instructional delivery models and student demographics have shifted significantly [1,2,3]. Traditional assessments, such as multiple-choice and essay-based exams, have been criticized for prioritizing memorization over application and for inadequately measuring clinical reasoning and communication skills [4,5]. These limitations are especially noticeable in Anatomy and Physiology (A&P), a foundational course for many health science pathways where student success is connected to later academic and clinical preparation [6]. In A&P, students must not only understand complex biological systems but also explain and apply that knowledge in patient-centered contexts.

Recent advances in generative artificial intelligence (AI) offer new opportunities to rethink assessment design. AI-powered chatbot assessments allow students to engage in structured dialogue, justify reasoning, and translate technical language into accessible explanations. Prior research has shown that AI-driven learning environments can enhance engagement, personalize instruction, and improve knowledge retention [7,8]. In medical education specifically, AI-supported tools have been identified as having the potential to support clinical reasoning, diagnostic decision-making, intelligent tutoring, and feedback in physician training [9]. However, empirical research examining AI as a **direct assessment mechanism**, rather than as tutoring or practice, remains limited, particularly in introductory A&P courses.

This article presents an exploratory mixed-methods pilot study examining the feasibility and perceived value of AI-powered chatbot assessments as an alternative assessment format in a fully online A&P I course.

Course Context and Assessment Design

The study was conducted across two fully online BIOL 2401 sections taught by the same instructor at Austin Community College in Austin, Texas, USA. Both sections followed identical learning objectives, pacing, laboratory experiences, grading thresholds, and academic integrity measures. Students completed weekly laboratory assignments, chapter-based quizzes, and extensive student-created video presentations requiring explanation, synthesis, and analogy-based reasoning.
The primary difference between sections was the **lecture assessment format**. In the traditional section, students completed proctored, time-restricted midterm and final exams. In the AI section, these exams were replaced with structured, proctored, time-restricted AI chatbot conversations. During these conversations, students led a dialogue with a virtual patient, explained anatomical and physiological concepts using correct terminology, and then reframed their explanations in patient-friendly language. The chatbot prompted clarification and elaboration but did not provide answers, aligning assessment with applied competency rather than recall.
This design reflects prior research emphasizing explanation-centered assessment, adaptive feedback, and instructional approaches intended to manage extraneous cognitive load and support deeper learning [10,11,12].

Methodology

An exploratory convergent mixed-methods pilot design was used, integrating quantitative survey data with qualitative open-ended responses. Participants were drawn from a convenience sample of students enrolled in two existing sections of Anatomy and Physiology. Students were not randomly assigned to the AI-supported or traditional assessment section; rather, they registered for sections through the institution's normal enrollment process. The AI-supported section was identified in the course schedule as using AI as a main assessment tool, while the traditional section included the same general online course expectations but did not include that AI assessment statement.
Each section began with 24 enrolled students. By the end of the semester, enrollment was 16 students in the AI-supported section and 19 students in the traditional section.
The study was reviewed and approved by the Austin Community College Institutional Research Review Committee in August 2025. Participation in the research component was voluntary and separate from completion of required course assessments. Electronic informed consent was obtained before research data were collected. A designated faculty liaison who was not affiliated with the course managed the consent process and withdrawal requests, and the instructor-researcher remained blinded to participant identities until final course grades had been submitted. Only de-identified data from students who provided consent were included in the analysis.
Four surveys were administered:

- Pre-assessment survey (combined sections; $n = 15$)
- End-of-course survey, AI section ($n = 8$)
- End-of-course survey, traditional section ($n = 4$)
- Post-assessment survey (combined sections; $n = 11$)

Quantitative items used Likert-scale measures to assess confidence, anxiety, perceived fairness, and alignment between assessments and learning. Qualitative items invited students to reflect on what they found easy or difficult and how assessments influenced their understanding.
Because the course was intensive in pace and workload, student participation varied across the semester. Some students completed surveys at the beginning and end of the course but did not participate at every data-collection point, while others completed only selected instruments. Consequently, response counts differed across surveys. Each survey instrument was analyzed separately, and the samples were not treated as longitudinally matched. No claims of individual change over time were made from comparisons among the surveys.

Data Analysis

Quantitative Likert-scale items were summarized descriptively at the survey-instrument level. Item means were retained to provide a transparent summary of the observed responses, but no inferential tests, effect estimates, or statistical comparisons were conducted. Because Likert items are ordinal and the response counts were small, unequal, and not longitudinally matched, the reported means were treated only as secondary contextual information. They were not interpreted as evidence of individual growth, population-level effects, or comparative effectiveness between assessment formats.

Open-ended responses were analyzed using an inductive qualitative content-analysis approach. The instructor-researcher read the de-identified responses multiple times and assigned initial descriptive codes to statements concerning memorization, explanation, application, assessment anxiety, communication, and interaction with AI. Related codes were then grouped into broader categories and reviewed against the original responses. These categories were refined into recurring themes that organized the qualitative findings. Representative quotations were selected because they clearly illustrated each theme rather than because they were assumed to represent all participants. Because the analysis was conducted by one researcher, no interrater reliability statistic was calculated, and the possibility of researcher interpretation bias is acknowledged as a limitation. Accordingly, the qualitative findings serve as the primary basis for interpretation, while the quantitative results provide limited descriptive context.

Results

Appendix Tables 1–3 provide a structured overview of the four survey instruments used in this study, including each instrument's timing, participant group, sample size, analytic purpose, selected qualitative excerpts, and descriptive quantitative findings. Because the surveys were administered at different points in the course and were not identical across all instruments, the tables are used to organize the findings rather than to suggest direct statistical comparison across groups. Table 1 outlines the purpose of each survey, Table 2 presents representative de-identified student responses, and Table 3 summarizes selected Likert-scale means related to confidence, explanation, application, anxiety or stress, and assessment fairness. The following sections discuss the quantitative and qualitative findings separately while drawing on these appendix tables as supporting evidence. Table 3 is retained to transparently report the observed Likert-scale responses but is not intended to support longitudinal or between-section statistical comparisons.

Quantitative Findings

Pre-assessment responses suggested that participants entered BIOL 2401 with moderate confidence in their ability to succeed but lower confidence in applying and explaining A&P concepts, alongside moderate-to-high assessment anxiety, a concern previously documented in health science education [13]. Most respondents also agreed that assessments should help them apply learning to real-life situations and that explaining concepts in their own words supported their learning. These responses provide baseline context regarding participants' expectations and concerns but cannot be linked to later responses at the individual level.

Across the end-of-course and post-assessment surveys, descriptive ratings generally fell within the Agree to Strongly Agree range for items related to confidence, application, communication, fairness, and perceived learning value. In the post-assessment survey, item means ranged from approximately 4.18 to 4.36 on a five-point scale for application- and communication-related items, while perceived assessment fairness had a mean of 4.27. AI-section respondents also reported favorable perceptions of explanation and real-life application. These means are retained to transparently summarize the observed survey responses, but they are not used to test differences, estimate effects, or demonstrate change over time.

These findings must be interpreted cautiously. Survey participation varied across instruments, responses were not longitudinally matched, and the end-of-course response counts were small and unequal, particularly in the traditional section, which included four respondents. The values therefore cannot demonstrate individual growth over time or support meaningful statistical comparisons between assessment formats. Quantitative findings are presented only as preliminary descriptive indicators of participant perceptions and should be interpreted alongside the qualitative findings rather than as evidence of comparative effectiveness.

Qualitative Findings

Four recurring themes were identified across the open-ended responses: moving beyond memorization through explanation, conversational assessment and perceived pressure, communication and applied reasoning, and challenges associated with interacting with AI. Given the small number of respondents, these themes describe patterns within the collected responses and should not be interpreted as representing the experiences of all students enrolled in either section.

Theme 1: Moving Beyond Memorization Through Explanation

Pre-assessment open-ended responses showed that several students distinguished memorization from meaningful understanding. One student explained that previous science exams often required them to "memorize and then regurgitate the information," making it difficult to remember the material later. Another student noted that explaining information in their own words helped them learn more effectively. These responses provide important baseline context, as students entered the course already aware that traditional study and testing practices did not always support long-term understanding.

AI-section respondents similarly emphasized explanation as a learning mechanism. One student stated, "It pushed me to actually understand the material because I had to explain it in my own words." This perception aligns with constructivist learning theory [14,15]. Related anatomy education research has also examined how adaptive learning approaches may support student engagement and flexible learning [16].

Theme 2: Conversational Assessment and Perceived Pressure

Some AI-section respondents described the assessment format as feeling more conversational and less like a conventional test. One student explained, 'It felt more like a conversation than a test.' A respondent in the combined post-assessment survey also reported that their motivation was higher and their stress had decreased. These statements reflect students' perceptions of the assessment experience rather than objective evidence that the format reduced anxiety. Nevertheless, the pattern is consistent with prior research suggesting that assessment structures can influence test-related stress [5,17].

Theme 3: Communication and Applied Reasoning

AI-section respondents described opportunities to explain their thought processes and communicate their knowledge more fully. One student stated that the assessments allowed them to "talk through my thought processes of the material learned," while another reported, "I was really able to display what I know, which is not something you typically get to do in a multiple-choice standard exam." These responses suggest that students perceived the chatbot format as emphasizing explanation, application, and communication rather than answer selection alone. Students in the traditional section valued the predictability of conventional exams but also acknowledged limitations. One respondent explained, "I can use process of elimination to get an answer if I don't necessarily know the question." Another described difficulty recalling every element required by short-answer prompts. Responses across both sections reflected awareness of the distinction between memorization and meaningful understanding, an outcome emphasized in competency-based medical education literature [4,9].

Theme 4: Challenges Associated with Interacting With AI

The AI-supported assessment was not perceived as uniformly easy or beneficial. One respondent noted, "The AI could be difficult to steer in the right direction or avoid being redundant." This response suggests that interacting with the chatbot introduced an additional technological and communication demand. Students were required not only to understand A&P content but also to learn how to communicate effectively with the AI. This theme highlights the importance of providing practice opportunities, clear expectations, and guidance before students complete AI-supported assessments. It also reinforces concerns raised in the literature regarding differences in students' familiarity with emerging technologies and the need for intentional AI-literacy scaffolding [18,19].

Discussion

Taken together, the preliminary qualitative themes and descriptive survey responses suggest that assessment format may be associated with how students approach explanation, application, and communication. AI-section respondents more frequently emphasized opportunities to explain their reasoning, communicate their understanding, and apply course concepts in a conversational context. Traditional-section respondents emphasized the predictability of conventional exams but also described limitations associated with recall and test-taking strategies. Because the sections were not randomly assigned and the response counts were small and unequal, these patterns should not be interpreted as evidence that one assessment format caused better learning outcomes.

These findings are consistent with prior research suggesting that AI-driven and adaptive learning systems may influence extraneous cognitive load, engagement, and opportunities for applied learning [8,12,20]. They also reinforce concerns raised in the literature regarding equity and access. Some students noted that learning how to interact effectively with the AI was itself part of the challenge, underscoring the need for AI-literacy scaffolding, clear expectations, and opportunities to practice with the technology [18,19].

Limitations

This exploratory pilot study is limited by its small convenience sample, unequal survey-response counts, lack of random assignment, and implementation within one course at a single institution. Because the AI-supported section was identified in the course schedule as using AI as a primary assessment tool, students may have self-selected into the section based on their prior interest in, comfort with, or attitudes toward AI. This self-selection limits the ability to attribute differences in student responses to the assessment format itself. Survey participation also varied across instruments and sections. The traditional-section end-of-course survey included only four respondents, compared with eight respondents from the AI-supported section. Students who elected to complete the surveys may have held stronger, more favorable, or otherwise different views from students who did not participate, creating the possibility of nonresponse bias. Anonymous responses were not matched longitudinally; therefore, apparent differences between beginning- and end-of-course responses cannot be interpreted as individual change.

The study relied primarily on self-reported perceptions and did not include objective measures of content mastery, long-term retention, standardized laboratory performance, or performance in subsequent clinical coursework. The qualitative analysis was conducted by one researcher, and no second coder or inter-rater reliability analysis was used. The instructor's dual role as course instructor and researcher may also have influenced interpretation. Although the consent and withdrawal process was managed by an independent faculty liaison and the instructor-researcher remained blinded to participant identities until final grades were submitted, the possibility of researcher interpretation bias cannot be eliminated. Findings should therefore be interpreted as preliminary and hypothesis-generating rather than as evidence of comparative effectiveness.

Conclusion and Implications

This article provides preliminary insight into students' experiences with AI-powered chatbot assessments as an alternative to traditional exams in fully online Anatomy and Physiology courses. AI-section respondents described the assessments as providing opportunities to explain concepts in their own words, articulate their reasoning, apply knowledge to patient-centered situations, and communicate complex information in accessible language. Some respondents also described the format as less anxiety-provoking than conventional testing. These statements represent students' perceptions and do not establish that the assessment format objectively improved understanding or reduced anxiety. Nevertheless, the findings suggest that AI-supported assessment may create opportunities for students to demonstrate forms of applied understanding that are not easily captured through answer-selection formats.

One important implication of this work is that assessment format may shape what students are asked to demonstrate. Later-course survey responses in both sections reflected generally favorable perceptions of confidence and understanding. However, because the surveys were anonymous and were not matched longitudinally, these responses cannot be interpreted as evidence that individual students' confidence increased over time. The AI-supported assessment required students to verbalize their reasoning, respond to follow-up prompts, and explain concepts in both technical and accessible language. These characteristics may be particularly relevant in A&P because many students are preparing for healthcare-related fields where success depends not only on content knowledge but also on communication, clinical reasoning, and the ability to translate complex information for patients. Larger studies using objective performance measures are needed to determine whether AI-supported assessments more effectively capture these forms of applied thinking.

At the same time, this study does not suggest that AI-based assessments should fully replace traditional exams. Traditional exams still provide value in measuring foundational knowledge, content recall, and readiness under structured conditions. However, they often fail to capture whether students can explain, apply, and communicate what they know. AI-based assessments may be most useful as a complementary assessment model that expands what counts as evidence of learning. When carefully designed, these assessments may help instructors evaluate dimensions of student understanding that are often difficult to measure through multiple-choice or short-answer exams alone.

The findings also point to the importance of intentional course design. AI assessment cannot simply be added to a course without preparation. Students need clear expectations, practice opportunities, rubrics, and guidance on how to interact with AI in ways that support learning rather than replace it. In this study, the AI chatbot did not provide answers; instead, it prompted students to clarify, elaborate, and explain their reasoning. This design choice is important because it positions AI as an assessment environment

rather than a shortcut. For AI-supported assessments to be equitable and effective, instructors must also consider students' varying levels of comfort with technology and provide scaffolding for AI literacy. For online A&P courses specifically, AI-powered chatbot assessments may help address a persistent challenge: how to create meaningful, rigorous, and authentic assessments in an asynchronous environment. Fully online courses often rely heavily on proctored exams to protect academic integrity, but those exams may not always reflect the depth of student learning. A structured chatbot assessment offers another possibility. It allows students to demonstrate knowledge through explanation while still working within time limits, proctoring expectations, and instructor-designed prompts. This creates a more applied assessment experience without removing academic accountability.

Future research should build on this exploratory study through larger sample sizes, more diverse institutional contexts, and longitudinal designs that examine whether AI-supported assessment influences student performance in later coursework, clinical programs, or professional communication tasks. Additional research should also compare student performance across different assessment types, including traditional exams, oral exams, written case studies, and AI chatbot conversations. Performance-based outcome measures would strengthen the evidence base and help determine whether students who complete AI-supported assessments demonstrate stronger long-term retention, application, or communication skills.

Overall, this study suggests that AI-powered chatbot assessments have the potential to reframe assessment in Anatomy and Physiology from a process focused primarily on recall to one that values reasoning, explanation, and communication. If students are being prepared for careers where they must think critically, communicate clearly, and apply biological knowledge to real human situations, then assessment practices should reflect those goals. AI-supported assessment, when designed with rigor, transparency, and equity in mind, offers one promising pathway toward that broader vision of learning.

Appendix.

Table 1. Survey Instruments and Analytic Purpose

Survey instrument	Timing	Group	Number of Participants (n)	Main Purpose
Pre-assessment survey	Beginning of course	Combined sections	15	Establish baseline student confidence, anxiety, and expectations before major assessments.
Post-assessment survey	Post-assessment	Combined sections	11	Capture overall reflection on how assessments supported understanding, application, confidence, engagement, and stress.
End-of-course survey: AI section	End of course	AI-supported assessment section	8	Capture student perceptions after completing structured AI chatbot assessments.
End-of-course survey: Traditional section	End of course	Traditional assessment section	4	Capture student perceptions after completing conventional exams.

Table 2. Qualitative Findings by Survey Instrument

Survey instrument	Group	Number of Participants (n)	De-identified quotation(s)
Pre-assessment survey	Combined sections	15	"All I'm trying to do when it comes to exams is memorize and then regurgitate the information to get a good grade." "Explaining concepts in my own words and teaching others has helped me understand the material the most."
Post-assessment survey	Combined sections	11	"I feel as though I am not just trying to regurgitate memorized information." "I was able to talk more conceptually about the topic instead of just answering." "My motivation has been higher and my stress has lowered."
End-of-course survey: AI section	AI-supported assessment	8	"These exams were very helpful because they allowed me to talk through my thought processes of the material learned." "I was really able to display what I know, which is not something you typically get to do in a multiple-choice standard exam." "The AI could be difficult to steer in the right direction or avoid being redundant."
End-of-course survey: Traditional section	Traditional assessment	4	"I can use process of elimination to get an answer if I don't necessarily know the question." "The short essays have always been a little challenging; sometimes it seems like I can't remember every single thing on the prompt." "The presentation part… helped me recall the information well during the exams."

Table 3. Selected Descriptive Likert-Scale Results by Survey Instrument

Survey instrument	n	Confidence/ understanding	Explanation/ communication	Application	Anxiety/ stress	Assessment fairness
Pre-assessment survey	15	A&P confidence M = 3.87	Explain scientific ideas M = 4.07	Apply learning to real-life situations M = 4.20	Usually anxious before exams M = 4.33	Prepared for assessment format M = 3.73
Post-assessment survey	11	Helped understand A&P M = 4.27	Confident explaining concepts M = 4.09; Express clearly M = 4.36	Apply rather than memorize M = 4.18	Less anxious as course progressed M = 4.00	Fair M = 4.27
End-of-course survey: AI section	8	A&P confidence M = 4.38	Explain scientific ideas M = 4.25	Real-life application M = 4.38	Usually anxious before exams M = 3.50	Comfort with new formats M = 4.38; Prepared M = 4.00
End-of-course survey: Traditional section	4	A&P confidence M = 4.25	Explain scientific ideas M = 4.00	Real-life application M = 4.50	Usually anxious before exams M = 4.25	Prepared M = 4.25

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The Use of AI in Higher Education: The Example of the UX Design Course for eHealth

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Abstract

Artificial intelligence (AI) is rapidly transforming higher education, including fields that combine technology and healthcare. This paper reports on experiences integrating AI-supported learning tools into a UX Design course in an eHealth master's program. Using Google NotebookLM as a structured self-study environment, students prepared independently for practical usability and accessibility evaluations conducted in face-to-face sessions. The course follows a blended learning format with four in-person sessions: the first introduces the course framework and a first display is developed by students; the second focuses on usability testing and individual oral examination; and the third covers accessibility evaluation and oral assessment. A final element, the fourth session, introduces external tools for remote usability testing. Between sessions, students engage in self-directed preparation guided by curated materials and structured question sets within Google NotebookLM. Assessment was conducted exclusively in face-to-face formats to ensure independent understanding. Student performance was strong, with a high pass rate and positive course evaluations. Qualitative feedback highlighted the value of structured AI-supported preparation and the practical relevance of the exercises. The experience suggests that AI tools can effectively scaffold learning in applied technology and health contexts when paired with clearly defined assignments, curated resources, and controlled assessment.

Keywords: *AI in education, UX design, eHealth systems, learning objectives, assessment integrity, workforce transformation*

1. Introduction

Artificial intelligence is rapidly reshaping higher education, opening new possibilities for supporting student learning, structuring self-directed study, and fostering engagement with complex subject matter [1], [2]. These developments are particularly salient in interdisciplinary fields such as eHealth, where students must integrate technical expertise with a nuanced understanding of human-centered design principles [3]. As a result, the meaningful integration of AI tools into teaching - while preserving academic integrity and maintaining rigorous assessment standards - has emerged as a central challenge for educators.

At the same time, AI is transforming entry-level work in software engineering and related domains. Recent analyses indicate that routine tasks traditionally assigned to junior professionals are increasingly being automated, leading to a shift in task profiles and elevated expectations for graduates. Rather than a decline in junior roles, the evidence suggests a reconfiguration of entry-level work, with growing emphasis on analytical, evaluative, and integrative competencies [7] - [9]. This shift disrupts traditional pathways of skill acquisition, as early-career professionals have fewer opportunities to develop expertise through routine tasks.

This paper presents the integration of Google NotebookLM as an AI-supported learning environment within a UX Design course in a master's program in eHealth at the University of Applied Sciences JOANNEUM Graz, Austria. The course focuses on usability and accessibility evaluation of digital health applications, combining structured theoretical preparation with practice-oriented exercises. To ensure the validity of learning outcomes, all assessment is conducted through face-to-face oral examinations, thereby isolating demonstrated competencies from AI-assisted preparation.

The paper details the course design, including the role of AI-supported self-study, the structure of in-person sessions, and the assessment approach. It further analyses the outcomes observed in the most recent cohort and discusses the conditions under which AI tools can effectively support learning in applied, practice-oriented educational settings.

Beyond reporting a course implementation, this work contributes to the emerging discourse on AI-enhanced education by demonstrating how structured AI-supported self-study, combined with curated content, guided tasks, and controlled assessment formats, can systematically foster higher-order competencies while maintaining academic integrity. The findings provide empirical and conceptual insights into how educational designs can respond to the transformation of entry-level roles and increasing competency demands in AI-augmented professional contexts.

2. Educational Context

The course “UX Design in eHealth” is embedded in a master's program that prepares students for professional roles in the development, evaluation and management of digital health technologies. The program draws students from diverse disciplinary backgrounds, including computer science, healthcare informatics, and health professionals. Students typically work part-time in industry or healthcare sector alongside their studies, bringing practical experience that shapes their engagement with course content.
Within the curriculum, the UX Design course sits at the intersection of interaction design, usability engineering and health informatics. Students learn to apply established evaluation methods - such as usability testing with think-aloud protocols and accessibility evaluation based on WCAG criteria - to digital health applications and displays. The course emphasizes the practical relevance of these methods for regulatory compliance and patient safety in eHealth contexts.
A central pedagogical challenge in this context is the need to develop both methodological knowledge and applied skills within a limited number of contact hours. The course addresses this challenge through a blended learning format that combines structured self-study supported by AI tools with practice-oriented in-person sessions and controlled individual assessment.
The European Union's Artificial Intelligence Act introduces requirements related to transparency, human oversight, and AI literacy. However, these obligations are not uniformly applied to all educational institutions. Instead, they depend on the role of an organization as a provider or deployer of AI systems. In particular, systems used for high-stakes decisions, such as student assessment or access to education, may fall under the high-risk category, whereas supportive learning tools typically do not [10].

3. Teaching Approach and Course Structure

The course is organized into four in-person sessions, between which students engage in self-directed preparation using Google NotebookLM. This structure reflects a flipped classroom approach: theoretical content and methodological foundations are acquired independently before the in-person sessions, which then focus on practical application and assessment.
The course design explicitly addresses the shift in competency requirements by focusing on higher-order cognitive skills, including problem framing, critical evaluation of AI-generated outputs, and methodological reasoning.
The integration of AI into this course follows a deliberate design principle: AI is positioned as a cognitive scaffold rather than a content substitute or autonomous tutor. This distinction matters. Where AI-as-tutor implies a conversational, adaptive relationship in which the system guides the learner dynamically, and AI-as-content-aggregator reduces AI to a search interface, AI-as-scaffold structures the learner’s own cognitive effort without replacing it. In practice, this means that Google NotebookLM was not used to generate answers for students, but to frame the intellectual territory they were expected to navigate independently. The curated question sets, structured answer outlines, and defined task boundaries ensure that AI amplifies active knowledge construction rather than enabling passive consumption. This design choice reflects established principles of generative learning and retrieval practice, which consistently show that effortful processing — not exposure to correct answers — drives durable understanding [4].
The course is designed for 20 – 30 students and comprises 30 teaching units of 45 minutes each, corresponding to a total of 2,5 ECTS credits. This structure allows for approximately 20 hours of self-directed study in addition to in-class instruction and assessment activities.

Table 1. Workload Breakdown

Component	Calculation	Hours
Total workload	2,5 ECTS	62,5
Lectures (in-person sessions)	30 × 0.75 hours	22.5
Exam preparation and assessment	—	20
Self-directed study	approx.	20

3.1 First In-Person Session: Course Introduction and Design of a Display

The first session introduces students to the course framework, learning objectives, examination modalities, and the general requirements of UX evaluation. A central element of this session is the assignment of a shared reference object for practical exercises: display systems used in public transportation.

Students work in groups of five and are assigned one of seven variants, ranging from urban tram displays to high-speed train information systems. This diversity of contexts enables comparative analysis while maintaining a consistent methodological approach across groups. An important advantage of this setting is that students are typically familiar with such systems as everyday users, allowing them to draw on prior knowledge of user needs and expectations.

During the session, students receive a structured introduction to the design rationale of their assigned system, including typical user groups, usage contexts, and relevant usability and accessibility considerations. The selected display systems serve as concrete and professionally relevant artefacts that form the basis for all subsequent evaluation exercises.

Following the first session, students begin their independent preparation for usability testing using Google NotebookLM. The AI-supported environment is based on curated course materials, including relevant sections of the course textbook, structured question sets, and detailed task descriptions for the practical exercises. Students work through approximately one hundred guiding questions, supported by concise answer outlines that help structure their preparation and consolidate their understanding of usability testing principles and methods.

3.2 Second In-Person Session: Usability Testing and Oral Examination

The second session focuses on the practical application of usability testing methods. Students conduct structured usability tests on the eHealth display introduced in the first session, working in small groups. They define test tasks, moderate sessions using the think-aloud method, take on observer roles, and systematically document identified usability issues. The results are compiled into short test reports and presented to the group, including recommendations for interface improvements.

Individual assessment takes place during this session in the form of face-to-face oral examination questions. Each student is assessed individually on their understanding of the usability testing methods applied. This controlled assessment format ensures that the results reflect independent understanding rather than group performance or AI-assisted preparation. The oral questions cover the theoretical foundations of usability testing, the specific methods applied, and the interpretation of findings.

After the second session, students complete a further phase of self-directed preparation, this time focused on accessibility evaluation. Using Google NotebookLM, they work through curated materials on WCAG criteria, automated and manual accessibility testing methods, and the relevance of accessibility in regulated eHealth environments. Structured question sets guide their preparation and help them build a methodologically sound understanding of accessibility evaluation.

3.3 Third In-Person Session: Accessibility Evaluation, Oral Examination

The third session opens with structured accessibility evaluations of selected websites. Students work in groups and choose a website from a predefined list; own proposals are also permitted. They apply WCAG-based criteria, use automated accessibility testing tools, and conduct manual checks, including keyboard navigation and screen reader testing. Identified accessibility barriers are documented and prioritized according to their severity and potential impact on target user groups. Each group presents its findings, answers follow-up questions, and demonstrates its understanding of WCAG principles.

As in the second session, individual oral examination questions are posed during the accessibility evaluation phase. Students are assessed on their understanding of WCAG criteria, the tools used, and

the interpretation of their findings. This format maintains the integrity of individual assessment within a group-based practical exercise.

3.4 Fourth In-Person Session: Remote Usability Testing Tools

The fourth session introduces students to external platforms and services for remote usability testing. This segment surveys current commercial and open-source tools for conducting unmoderated and moderated remote usability studies, highlighting their relevance for professional eHealth development contexts. Following this introduction, practical demonstrations and explanations are provided by an additional external specialist who is actively working in this field. Students discuss the methodological trade-offs between in-person and remote evaluation formats and explore how remote testing tools can complement laboratory-based approaches in practice.

4. Results

From the instructor's perspective, the examination results and student presentations were assessed as highly positive. An objective comparison with previous cohorts is not possible, as the course was newly designed in this format and no directly comparable baseline exists. Nevertheless, the instructor's subjective assessment is that students performed noticeably better than in conventionally delivered courses. While this observation is inherently subjective, it may be considered an indicative signal of the effectiveness of the applied teaching approach.

The official course evaluation was conducted using the evasys system. Of 23 eligible students, 5 participated in the evaluation, corresponding to a response rate of 21.7%. Despite the small sample size, the results were consistently positive across all dimensions. Overall course quality was rated “very good” by 4 out of 5 students, with one student giving the second-best rating. Organisational conditions, including the length of the in-person blocks and room equipment, received similarly high ratings. All five students confirmed that the workload corresponded appropriately to the assigned ECTS credit points.

The evaluation results indicate a consistently structured approach and a high level of methodological correctness. These findings suggest effective learning outcomes; however, they should be interpreted with caution given the limited sample size of the evaluation data.

The course was also enriched by one guest lecturer, which 4 out of 5 evaluating students confirmed as a clear added value for the course. Students noted that the guest contribution provided valuable insight into professional practice and was well integrated into the course flow. Preparation for the English-language guest lecture was highlighted as particularly helpful, enabling students with varying levels of English proficiency to follow and engage with the content effectively.

Ratings for the instructor dimensions were also very positive. The working climate in the course was rated “very good” by all five students. The connection between theory and practice received the highest possible rating from all respondents. Didactic methods and the quality of course materials received strong ratings. Accessibility of the instructor was rated positively by all students. Four out of five students confirmed that the assessment scheme, including grading criteria and examination modalities, was clearly understandable.

Qualitative feedback collected through open-response questions reinforced the quantitative findings. Students particularly valued the open and practice-oriented teaching style, noting that attendance alone provided substantial learning gains. The joint discussion and improvement of real-world examples of good and poor UX implementation was highlighted as especially valuable. Students also appreciated the opportunity to work through examination topics themselves, which they found deepened their understanding and enabled direct application during the in-person sessions. Representative feedback included comments such as: keep everything as it is, and please continue teaching in this open and practice-relevant way.

5. Discussion

The results of the course evaluation provide consistent evidence for the effectiveness of the proposed teaching design. In particular, the strong alignment between theoretical instruction and applied, practice-oriented exercises indicates that the course successfully operationalizes a key requirement of contemporary software engineering education: the integration of methodological rigor with real-world relevance. This is especially significant in a master's program context, where students are typically working professionals and expect immediate applicability of acquired competencies.

The qualitative feedback further supports the contribution of the approach by highlighting the value of example-based, comparative learning using real-world UX cases. Students consistently emphasized that the structured combination of self-study and in-person application enabled deeper engagement with complex problems. This finding suggests that the blended learning design, supported by AI-based preparation, effectively shifts classroom time from content delivery to higher-order cognitive activities, thereby increasing learning efficiency and depth [2].

A central contribution of this work lies in demonstrating how structured AI-supported self-study can enhance active knowledge construction. Students reported that independently working through examination-relevant content significantly improved their understanding and ability to apply methods in practice. This aligns with established principles of retrieval practice and self-explanation and indicates that AI tools, when embedded in a guided and curated framework, can support generative learning processes rather than superficial knowledge acquisition [4].

It is important to acknowledge the limitations of AI-supported self-study as implemented in this course. Google NotebookLM operates within the boundaries of curated source materials and cannot dynamically adapt to individual students' misconceptions or knowledge gaps in real time. Students who engage superficially with the guided question sets — reading answer outlines without actively constructing their own responses — risk acquiring a surface-level familiarity that does not translate into transferable competence. The oral examination format is precisely designed to surface this distinction: students who have genuinely engaged with the material can explain, justify, and apply concepts under questioning, while those who have not are identifiable through the conversation. This underscores a broader design principle: the effectiveness of AI-supported learning depends not on the sophistication of the AI tool, but on the quality of the surrounding pedagogical structure — including the tasks, the curation, and above all, the assessment format that makes genuine understanding non-optional.

The integration of external expert input through guest lectures provides additional evidence for the scalability and practical relevance of the approach. The successful preparation of students for an English-language guest lecture across varying levels of language proficiency illustrates how structured scaffolding can make advanced and potentially demanding learning experiences accessible. This highlights the broader applicability of the concept in heterogeneous learning environments and supports its transferability to other domains [6].

While the evaluation results should be interpreted with appropriate methodological caution, it should be noted that the response rate of 21.7% (5 out of 23 students) is within the range commonly reported for voluntary course evaluations in higher education, where response rates between approximately 20% and 40% are frequently observed [11], [12]. This reflects a broader structural challenge rather than a limitation specific to this course. Within this context, the consistently positive pattern across both quantitative and qualitative feedback still provides meaningful indications of the effectiveness of the design.

A particularly relevant contribution concerns the design of the assessment approach. By conducting all individual assessment through face-to-face oral examinations, the course ensures that demonstrated competencies reflect genuine individual understanding, despite extensive use of AI tools during preparation. This explicit separation between AI-supported learning and human-controlled assessment represents a robust design principle for maintaining academic integrity in AI-enhanced educational settings [3]. The results indicate that students are able to translate AI-supported preparation into authentic, independently demonstrated competencies.

6. Conclusion

This paper has reported on the design and outcomes of an AI-enhanced UX Design course in an eHealth master's program, in which Google NotebookLM served as a structured self-study environment embedded within a blended learning format assessed exclusively through face-to-face oral examination. The official course evaluation, conducted via the institutional evasys system, returned consistently positive ratings across all dimensions, including overall quality, working climate, the connection between theory and practice, and didactic methods. All five responding students confirmed that the workload corresponded to the assigned ECTS credit points. Qualitative feedback emphasized the value of the open and practice-oriented teaching style, the joint analysis of real-world UX examples, and the structured self-directed preparation of examination topics. The guest lecture component was rated as a clear added value by all students who experienced it.

The experience suggests that AI-supported learning environments can effectively scaffold student preparation in applied technology and health contexts, particularly when paired with curated resources, clearly defined assignments, a concrete shared reference object such as a purpose-built eHealth

display, and assessment formats that ensure individual accountability. The combination of AI-supported self-study, practice-oriented in-person sessions, and face-to-face oral examination appears to support both learning depth and assessment integrity.
Future development of this teaching approach will focus on increasing student participation in course evaluations to enable more robust conclusions, expanding the range of eHealth interface types used in the practical exercises, and exploring the integration of remote usability testing platforms directly into the course assignments.
The approach also reflects emerging labor market requirements, where graduates must demonstrate the ability to critically evaluate AI-generated outputs and integrate them into complex problem-solving contexts.
In addition to evaluating the effectiveness of the teaching approach, it is important to situate the course design within the broader transformation of software engineering education driven by artificial intelligence. In particular, three questions arise: how such a concept prepares students for changing entry-level roles, how it enables the development of higher competence levels in both foundational knowledge and AI-supported work, and how it contributes to increasing AI literacy among instructors. The following paragraphs address these aspects in relation to the presented course design.

6.1 Preparation for Changing Entry-Level Roles

The course design responds directly to the reconfiguration of entry-level roles in software engineering and related technology fields. As routine analytical and testing tasks are increasingly automated, graduates entering the workforce are expected to operate at higher cognitive levels from the outset — framing problems, critically evaluating tool outputs, and exercising methodological judgment rather than executing predefined procedures. The course addresses this shift by deliberately foregrounding higher-order competencies: students do not simply learn to run a usability test, but to select appropriate methods, interpret ambiguous findings, prioritize issues by severity and context, and communicate conclusions to professional audiences. Critically, they are expected to demonstrate these competencies independently, under examination conditions that exclude AI assistance. This prepares graduates not only to work alongside AI tools in professional practice, but to exercise the kind of evaluative and contextual judgment that AI cannot yet replicate — precisely the competencies that define the reconfigured entry-level role [7]–[9]. Through the blended learning approach with AI tools, students learn very early on how to increase the productivity and quality of their own products or services. This will help them when entering the job market.

6.2 Achieving Higher Competence Levels (Fundamentals and AI Use)

This paper contributes evidence that higher competence levels can be achieved through the deliberate integration of foundational knowledge and structured AI usage. The combination of curated materials, guided question sets, and clearly defined tasks ensures that AI functions as a cognitive scaffold rather than a substitute for understanding. The results indicate that this design supports deep learning, critical evaluation, and effective transfer to applied contexts, while controlled, AI-free assessment safeguards the validity of demonstrated competencies.

6.3 Increasing AI Literacy Among Instructors

The findings further contribute to the understanding of how AI literacy among instructors can be developed through practice-oriented course design. By actively engaging in the curation of AI-supported learning environments, structuring interactions with AI tools, and maintaining human oversight in assessment, instructors acquire a grounded and reflective understanding of AI capabilities and limitations. This suggests that AI literacy is most effectively developed as an embedded, experiential competence within teaching practice rather than through isolated training measures.

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Operationalizing the Metaverse in South African Higher Education: A Readiness Assessment and Strategic Framework

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Abstract

The metaverse has emerged as a transformative digital innovation with the potential to reshape higher education and Technical and Vocational Education and Training (TVET) through immersive, interactive, and experiential learning environments. Building on the foundational work of [1], which identified the metaverse as a potential solution to study space shortages in South African higher education institutions, this study investigates institutional readiness, stakeholder perceptions, and strategic pathways for operationalising metaverse technologies within South African Higher Educational Institutions (HEIs), especially TVET colleges. The study is situated within the broader national agenda to expand post-school education and training, particularly the goal of increasing TVET enrolments to approximately 2.5 million students by 2030 [2, 3]. Given growing enrolments, infrastructure constraints, and the need for innovative approaches to skills development, the metaverse presents opportunities to enhance access, experiential learning, and vocational training while reducing pressure on physical facilities. A qualitative research design was employed, with data collected through semi-structured interviews involving academic leaders, digital transformation specialists, educators, and policy advisors. Data were analysed using [4] thematic analysis framework. Five key themes emerged: institutional infrastructure readiness, digital competencies and capacity building, policy and governance readiness, implementation challenges and risks, and opportunities associated with metaverse adoption. The findings reveal growing institutional interest in immersive technologies and evidence of emerging digital readiness; however, significant challenges remain, including infrastructure disparities, inadequate digital competencies, limited policy frameworks, funding constraints, cybersecurity concerns, and persistent inequalities across institutions. Participants nevertheless highlighted the metaverse's potential to enhance experiential learning, simulation-based training, student engagement, and access to vocational education. In response to these findings, the study proposes a Metaverse Readiness and Implementation Framework (MRIF) to guide institutions through readiness assessment, governance development, stakeholder engagement, capacity building, phased implementation, and continuous evaluation. The framework provides a contextually relevant roadmap for supporting sustainable, inclusive, and strategically governed metaverse adoption within South African higher education especially TVET colleges.

Keywords: *Metaverse, Virtual Study Spaces, Higher Education, TVET colleges, Digital Learning, Virtual Reality, Education Technology*

1. Introduction

The global higher education sector is experiencing significant transformation as institutions respond to the rapid technological changes associated with the Fourth Industrial Revolution (4IR). Emerging digital technologies such as artificial intelligence (AI), virtual reality (VR), augmented reality (AR), blockchain, and extended reality (XR) are reshaping teaching, learning, research, and institutional operations [5, 6]. Within this evolving digital ecosystem, the metaverse has emerged as a transformative innovation with the potential to redefine educational delivery and student engagement in higher education. The metaverse refers to a persistent, immersive, and interconnected virtual environment in which users interact through digital avatars in real time using advanced immersive technologies [7, 8]. In educational contexts, the metaverse enables experiential, collaborative, and interactive learning beyond the limitations of physical classrooms. Through virtual laboratories, simulations, digital campuses, and immersive collaborative spaces, the metaverse offers opportunities to enhance student engagement, improve accessibility, and support innovative pedagogical practices aligned with constructivist and connectivist approaches to learning [9].

Globally, universities are increasingly exploring metaverse applications to support flexible and technologically enhanced learning environments. Institutions in developed countries have begun

implementing immersive learning platforms for disciplines such as engineering, medicine, architecture, and teacher education, where simulation-based learning can improve practical competence and student participation [6]. The metaverse is further viewed as an important component of digital transformation strategies aimed at improving institutional competitiveness, innovation, and global collaboration in higher education. The need for innovative approaches to educational delivery is further amplified by South Africa's national skills development agenda. The National Development Plan (NDP) 2030 and the White Paper for Post-School Education and Training position TVET colleges as critical institutions for addressing unemployment, poverty, and economic growth through skills development [2, 3]. To achieve these objectives, government has set ambitious enrolment expansion targets for the TVET sector, with long-term plans aimed at accommodating approximately 2.5 million students. However, expanding enrolments at this scale presents significant challenges relating to infrastructure, equipment, workshop space, and lecturer capacity. Emerging technologies such as the metaverse may provide innovative opportunities to support expanded access and quality vocational training through immersive and scalable learning environments. Existing studies suggest that the metaverse may provide innovative solutions to challenges such as overcrowded campuses, limited physical infrastructure, and restricted access to practical learning environments [1].

Despite these opportunities, the adoption of metaverse technologies remains uneven across different socio-economic and institutional contexts. In developing countries such as South Africa, higher education institutions continue to face structural and systemic barriers that hinder advanced digital transformation initiatives. These challenges include inadequate digital infrastructure, unstable internet connectivity, electricity disruptions, limited financial resources, insufficient technical expertise, and persistent inequalities between historically advantaged and disadvantaged institutions [10, 11]. Such disparities significantly affect institutional capacity to adopt sophisticated immersive technologies and may deepen existing educational inequalities if not adequately addressed. The COVID-19 pandemic further exposed the vulnerability of South African higher education institutions especially TVET colleges regarding digital readiness and technology integration. Although some institutions successfully transitioned to online and blended learning models, many institutions experienced significant challenges related to infrastructure limitations, staff preparedness, student access to digital devices, and affordability of internet connectivity [12, 13]. The pandemic highlighted the persistent digital divide within South African higher education especially TVET colleges, particularly among students from rural and economically disadvantaged communities, thereby raising concerns about equitable access to emerging technologies such as the metaverse [14].

Furthermore, despite the increasing global interest in metaverse technologies as transformative tools for education, there is limited empirical evidence regarding the readiness of South African post-school institutions, particularly TVET colleges, to adopt and implement immersive learning environments. TVET colleges face unique challenges associated with infrastructure constraints, unequal access to digital technologies, lecturer digital competencies, and the need to deliver practice-oriented learning experiences that mirror real workplace environments. Although immersive technologies may offer innovative solutions for vocational training through virtual simulations, laboratories, and workplace-based learning experiences, little is known about the institutional, technological, and human-capacity requirements necessary for successful implementation. Consequently, the absence of context-specific readiness frameworks creates uncertainty regarding the feasibility, sustainability, and equity implications of metaverse adoption within South African TVET colleges and the broader higher education sector. The study aims to investigate institutional readiness, stakeholder perceptions, and strategic pathways for operationalising metaverse technologies within South African HEIs, especially TVET colleges.

2. Review of Related Literature

2.1 Theoretical and Conceptual Foundations

The integration of metaverse technologies in higher education is grounded in several technology adoption and digital learning frameworks. Diffusion of Innovation Theory posits that technological adoption depends on perceived usefulness, compatibility, complexity, and institutional support [15]. Similarly, the Technology Acceptance Model (TAM) emphasizes that perceived usefulness and ease of use directly determine user willingness to adopt new tools [16]. In the metaverse context, educators and students embrace immersive platforms when they perceive them as catalysts for teaching effectiveness and enhanced learning. Pedagogically, constructivist and connectivist learning theories support this immersion. Constructivism states that learners actively build knowledge through interactive experiences,

while connectivism emphasizes digital networking and collaborative learning [17]. The metaverse merges these views by offering highly interactive, experiential, and collaborative virtual environments.

2.2 Digital Transformation in Higher Education

Digital transformation is a global strategic priority driven by the Fourth Industrial Revolution (4IR), which has integrated artificial intelligence, cloud computing, virtual reality, and learning management systems into universities to improve access and quality [5]. This shift demands deep organizational change, pedagogical innovation, and process restructuring [18]. In South Africa, the COVID-19 pandemic forced a rapid transition to online and blended models [12], but exposed severe institutional inequalities in digital readiness, infrastructure, and staff preparedness between historically advantaged and disadvantaged universities [19]. Today, local digital transformation remains constrained by inadequate funding, unstable internet access, rolling power outages, and limited digital competencies among students and academics [10], barriers that heavily impede metaverse adoption.

2.3 Metaverse and Immersive Learning

The metaverse is an interconnected, real-time virtual ecosystem where users interact via avatars through a blend of virtual/augmented reality, artificial intelligence, and blockchain [7, 8]. Educationally, it facilitates boundaryless, simulation-based learning through virtual laboratories and collaborative projects [6]. These immersive environments boost student engagement, motivation, and knowledge retention via active participation [9]. Furthermore, virtual campuses can help institutions bypass physical infrastructure limits and overcrowding, expanding access to practical, lab-based disciplines [1]. However, scholars note that deployment is hindered by high financial costs, cybersecurity threats, privacy issues, and complex ethical governance [20].

2.4 Metaverse Applications in TVET Education

Technology-enhanced learning is critical for the South African Technical and Vocational Education and Training (TVET) sector, where curricula demand hands-on, occupational competencies. The metaverse offers virtual workshops and industry environments where students can practice technical skills safely and repeatedly, overcoming physical workshop limitations. This immersive framework directly fosters the technical and employability skills required for Industry 4.0 [6, 8]. The National Development Plan (NDP) 2030 positions TVET colleges as central to tackling youth unemployment, while the White Paper for Post-School Education and Training targets massive growth to 2.5 million [2, 3]. Expanding via brick-and-mortar infrastructure is financially impossible. Metaverse technologies offer a viable alternative pathway to scale training capacity, reach remote learners, and offer flexible delivery models [1]. This potential, however, depends heavily on whether institutions possess the necessary infrastructure, policy frameworks, and human capacity.

2.5 Institutional Readiness for Technology Integration

Institutional readiness is the baseline technological, financial, human, and organizational capacity required to successfully implement innovation. It encompasses digital infrastructure, clear policy frameworks, leadership commitment, staff competencies, and supportive organizational culture [21]). Institutions with strong leadership and robust digital policies deploy emerging technologies effectively [22]. Conversely, low readiness sparks user resistance and widens educational inequalities. In South Africa, readiness remains highly uneven; rural and historically disadvantaged institutions face persistent bandwidth limitations, infrastructure deficits, and severe funding gaps [11].

2.6 Challenges of Digital Transformation in South African Higher Education

Digital transformation in South African universities is severely impeded by systemic socio-economic and technical barriers. Chief among these is the persistent digital divide, which restricts equitable access to devices, reliable internet, and online learning platforms for students from low-income or rural backgrounds [14]. Operational hurdles include rolling power outages (load shedding), deficient broadband infrastructure, legacy technological hardware, and under-resourced ICT support desks ([23]. Furthermore, widespread institutional financial constraints restrict high-end investments in immersive tech and academic training. These infrastructural issues are compounded by human barriers, notably

academic resistance to change, gaps in digital literacy, and missing institutional policy frameworks [24]. Consequently, adopting advanced systems like the metaverse demands comprehensive institutional restructuring rather than simple technological procurement.

2.7 Opportunities and Risks of Immersive Technologies

Immersive platforms offer powerful avenues to elevate higher education by hosting experiential, simulation-driven learning that sharpens 21st-century competencies like creative problem-solving and deep digital literacy [25]. Conversely, deploying these systems introduces profound ethical, operational, and psychological risks. Key vulnerabilities include data privacy breaches, cybersecurity threats, and psychological strain from extended virtual immersion [20]. Furthermore, the steep capital required for advanced hardware, software licensing, and specialized staff training presents a major barrier for budget-constrained universities. If unmitigated, these costs risk deepening student exclusion. Successful metaverse integration therefore hinges on rigorous strategic planning, ethical policy frameworks, stakeholder alignment, and proactive equity strategies.

3. Research Methodology

This study employed a qualitative research approach grounded in the interpretivist paradigm to explore institutional readiness for metaverse integration in South African higher education institutions [26]. An exploratory case study design was adopted to gain in-depth insights into stakeholders' perceptions, experiences, and preparedness regarding immersive technologies in teaching and learning [26].

3.1 Participant Selection

A purposive sampling technique was used to select 8 participants with relevant knowledge and experience in digital transformation and educational technology integration. Using purposive sampling enabled the researcher to obtain rich and contextually relevant data from participants directly involved in institutional technology adoption processes [26]. The selected participants included academic staff, ICT personnel, institutional managers, and e-learning coordinators involved in digital transformation initiatives within HEIs.

3.2 Profiles of Participants

The eight participants were purposively sampled to provide a comprehensive, multi-level overview of the post-school education and training sector, spanning national policy, institutional management, and frontline execution.
National Policy Level: Mr Sello Sethusha (DHET Director of Lecturer Development and Support) and Dr Moyo Mtheto (DHET Acting Director of International Scholarships) were selected to provide critical insights into national capacity-building frameworks, international education partnerships, and the broader policy landscape governing metaverse adoption. Institutional Leadership & eLearning Strategy: Ms Zandile Nkabinde (Deputy Principal, Majuba TVET College) was chosen to offer a strategic perspective on institutional management, focusing on resource allocation, operational infrastructure constraints, and staff readiness. Complementing this, Ms Phumzile Mthiyane (Deputy Chief Education Specialist, eLearning Directorate) was selected for her specialized expertise in designing and integrating digital learning policies. Frontline Classroom Execution: Four TVET college lecturers; Ms Khathu Mangaladzi (CJC TVET College), Mr Dlamini (Majuba TVET College), Ms Precious, and Ms T.G. Ndou (both Vhembe TVET College), were selected to capture the practical realities of daily teaching, user-level experiences with digital tools, and the pedagogical shifts needed for immersive learning.

3.3 Data Collection

Data was collected through semi-structured interviews conducted either face-to-face or via online platforms such as Microsoft Teams and Zoom. The interviews focused on institutional infrastructure, digital competencies, policy readiness, implementation challenges, and opportunities associated with metaverse adoption.

3.4 Data Analysis

Data was analysed using thematic analysis following the six-phase framework developed by [4], enabling the identification and interpretation of recurring themes and patterns within the data. The process included familiarization with data, generating initial codes, generating initial themes reviewing potential themes, defining and naming themes, and producing the report. To ensure trustworthiness, the study applied the principles of credibility, dependability, confirmability, and transferability as proposed by [27]. Ethical considerations, including informed consent, confidentiality, anonymity, and voluntary participation, were observed throughout the study.

4. Findings

Using [4] six-phase thematic analysis framework, five overarching themes emerged from the interview data: (1) Institutional Infrastructure Readiness, (2) Digital Competencies and Capacity Building, (3) Policy and Governance Readiness, (4) Implementation Challenges and Risks, and (5) Opportunities and Future Potential of the Metaverse. These themes provide insights into the readiness of South African higher education institutions and TVET colleges to adopt metaverse technologies and inform the development of a strategic framework for implementation.

4.1 Institutional Infrastructure Readiness

Participants acknowledged significant progress in digital transformation, particularly following the COVID-19 pandemic, through the adoption of Learning Management Systems (LMSs), online learning platforms, and blended learning approaches. However, readiness was found to be uneven across institutions, with disparities in infrastructure, connectivity, and access to digital resources remaining a major concern.

One participant highlighted both the progress made and the existing challenges:

“TVET colleges have made massive progress by adopting LMSs and online teaching platforms, but there are still limitations because of inadequate bandwidth, outdated computers, insufficient software licences and shortages of modern devices.”

Similarly, a senior DHET official emphasised the inequalities that continue to characterise the higher education landscape:

“We have urban universities, rural universities, historically white universities and historically black universities… some rural universities did not have the basic equipment, basic internet connection and basic computers.”

4.2 Digital Competencies and Capacity Building

The second theme focused on the digital competencies required for successful metaverse implementation. Participants consistently emphasised educator training, technical support, and continuous professional development as critical enablers of adoption.

As one participant explained:

“The educators would require hands-on technical training, instructional design support, continuous professional development, mentoring and communities of practice, technical support services and clearly defined policies.”

Participants also recognised that students may adapt more quickly to immersive technologies than educators due to greater familiarity with digital environments:

“Students may embrace immersive technologies because it aligns with their experiences… but some educators have cyberphobia and fear of technology.”

4.3 Policy and Governance Readiness

Policy and governance readiness emerged as one of the weakest dimensions of institutional preparedness. Although institutions have increasingly embraced digital technologies, participants reported the absence of comprehensive policies to guide the implementation and governance of immersive technologies.

One participant stated:

“I don’t think we have policies in our institutions that guide us about how to utilise technology and how to manage technology.”

Another participant highlighted the broader governance responsibilities associated with metaverse adoption:
“The issue is what support must policymakers provide to universities. That is funding… and also issues of ethics as well because embedded in the metaverse are issues of AI.”
Participants argued that policy frameworks should address ethical governance, cybersecurity, accessibility, artificial intelligence, and sustainable funding.

4.4 Implementation Challenges and Risks

Participants identified several challenges that could hinder the adoption of metaverse technologies, including financial constraints, inadequate infrastructure, digital inequality, cybersecurity concerns, and resistance to change.
One participant summarised these concerns succinctly:
“Financial constraints, inadequate digital infrastructure, inequality in access to devices, cybersecurity and data privacy concerns, lack of policies and resistance to change.”
Participants were particularly concerned about the potential for metaverse implementation to exacerbate existing inequalities within the higher education sector:
“The institutions should be very careful that they don’t widen the existing inequalities… equity should be embedded into every stage of implementation. Nobody should be left behind.”
Without targeted interventions, metaverse adoption may reinforce existing inequalities rather than address them.

4.5 Opportunities and Future Potential of the Metaverse

Despite these challenges, participants overwhelmingly viewed the metaverse as a transformative educational innovation capable of enhancing experiential learning, improving access, and supporting practical skills development.
A tourism lecturer illustrated the educational possibilities offered by immersive technologies:
“I can take my students to Table Mountain while I’m in Johannesburg… students are going to be provided with simulated environments and engage with experiential learning.”
Another participant highlighted the value of simulations for practical learning:
“Visual simulations will provide students with realistic learning experiences that may otherwise be expensive or inaccessible.”
Participants viewed the metaverse as particularly beneficial for engineering, tourism, hospitality, logistics, aviation, and vocational education programmes that require practical and experiential learning opportunities.

5. Discussion

The findings demonstrate that institutional readiness for immersive technology in a developing country context cannot be viewed as a purely technological phenomenon. Instead, it is a complex sociotechnical ecosystem where infrastructure, digital literacies, institutional governance, and socio-economic history collide.
A critical finding of this study is the persistent unevenness of institutional infrastructure readiness, which is starkly divided along historical lines (urban vs. rural and historically white vs. historically black institutions). While the post-COVID-19 era accelerated the baseline adoption of Learning Management Systems (LMSs) and blended modalities across South Africa, this study shows that transitioning to the metaverse requires an entirely different order of technological capital. The presence of basic internet and outdated hardware does not equate to metaverse readiness, which demands massive bandwidth, low-latency connectivity, high-end graphic processing power, and specialized peripheral hardware (e.g., VR headsets).
This infrastructure disparity strongly echoes the warnings of [11] and [10], who argue that blanket digital transformation policies frequently fail because they ignore underlying institutional inequalities. Within the broader South African discourse, these results add an immersive-technology layer to the structural digital divide documented by [14]. If South African higher education blindly deploys metaverse spaces without targeted capitalization, it risks cementing a two-tier educational system: a technologically enriched immersive experience for well-resourced urban universities, and a text-based, resource-constrained experience for rural and TVET campuses. Therefore, infrastructure readiness must be

conceptualized not just as "having technology," but as achieving equity of access to specialized technical architectures.

The findings indicate that technological infrastructure is entirely inert without a corresponding upgrade in human capability. The data revealed a stark contrast between a highly digitally fluent student body and an instructional workforce constrained by technical limitations and, in some cases, "cyberphobia." This dynamic can be directly interpreted through the lens of [16] Technology Acceptance Model (TAM). According to TAM, a user's intention to adopt a system is driven by its Perceived Usefulness (PU) and Perceived Ease of Use (PEOU). While the educational utility (PU) of the metaverse is widely acknowledged, its perceived ease of use among educators remains low due to a lack of instructional design support and hands-on technical training.

Furthermore, this human capital gap illustrates the structural bottlenecks predicted by [15] Diffusion of Innovations Theory. For an innovation to diffuse successfully through an organization, the social system must provide clear compatibility and observability. The findings highlight that South African institutions currently lack the organizational support systems needed to transition educators from "laggards" or "late majorities" into active adopters. This underscores that human capital development cannot be an afterthought; continuous professional development must run parallel to any hardware procurement.

Perhaps the most vulnerable dimension of readiness identified is the systemic absence of policy and governance frameworks tailored to immersive environments. While institutional policies have slowly adapted to traditional online learning, they are completely unequipped to handle the unique ethical, legal, and operational complexities of the metaverse. This policy vacuum aligns with observations by [21] and [22], who assert that institutional leadership and agile governance are the primary gatekeepers of sustainable digital transformation. Implementing the metaverse without predefined regulatory guardrails poses catastrophic risks regarding student safety, identity theft, and institutional liability. Furthermore, because the metaverse blurs geographical and physical boundaries, it creates complex questions around digital rights management and algorithmic bias. The findings imply that state bodies, such as the Department of Higher Education and Training (DHET), alongside institutional councils, must proactively move away from reactive policymaking and instead co-design proactive, ethically grounded governance frameworks that explicitly address immersive spaces.

When evaluating the data holistically, a profound paradox emerges between the identified risks (Theme 4) and the perceived opportunities (Theme 5) of the metaverse. On one hand, the metaverse introduces extreme financial strains onto already burdened public budgets and risks worsening the digital divide [24]. On the other hand, it offers unprecedented pedagogical opportunities for experiential, simulated, and collaborative learning that could democratize access to expensive physical training.

This pedagogical potential is highly consistent with constructivist and connectivist learning theories [17], which position learning as an active, networked process of generating meaning through experience. In disciplines that require expensive or high-risk physical infrastructure the metaverse offers an elegant solution to resource scarcity. As argued by [8], [9], and [6], high-fidelity virtual simulations allow students to bridge the gap between theory and practice safely and iteratively. The core implication is that the metaverse should not be pursued as a novelty or a generic replacement for traditional lectures; rather, its implementation must be highly strategic, targeting specific spatial, practical, and experiential learning modules where virtual simulation provides a clear, cost-effective educational advantage over physical infrastructure.

6. Proposed Framework

The Proposed Strategic Framework for Operationalising the Metaverse in South African Higher Education and TVET Colleges in **Figure 1** below provides a structured roadmap for institutions to assess readiness, implement immersive technologies, and sustain innovation in teaching and learning. Grounded in Constructivism, Connectivism, the Technology Acceptance Model, and Diffusion of Innovation Theory, the framework integrates six sequential phases which are institutional readiness and policy development to stakeholder engagement, pilot implementation, scaling, and sustainability. Each phase aligns technological adoption with human capacity, governance, pedagogy, and strategic vision, ensuring that metaverse integration advances equity, inclusivity, and digital transformation. Ultimately, the framework empowers universities and TVET colleges to transition toward experiential, data-driven, and future-ready education ecosystems.

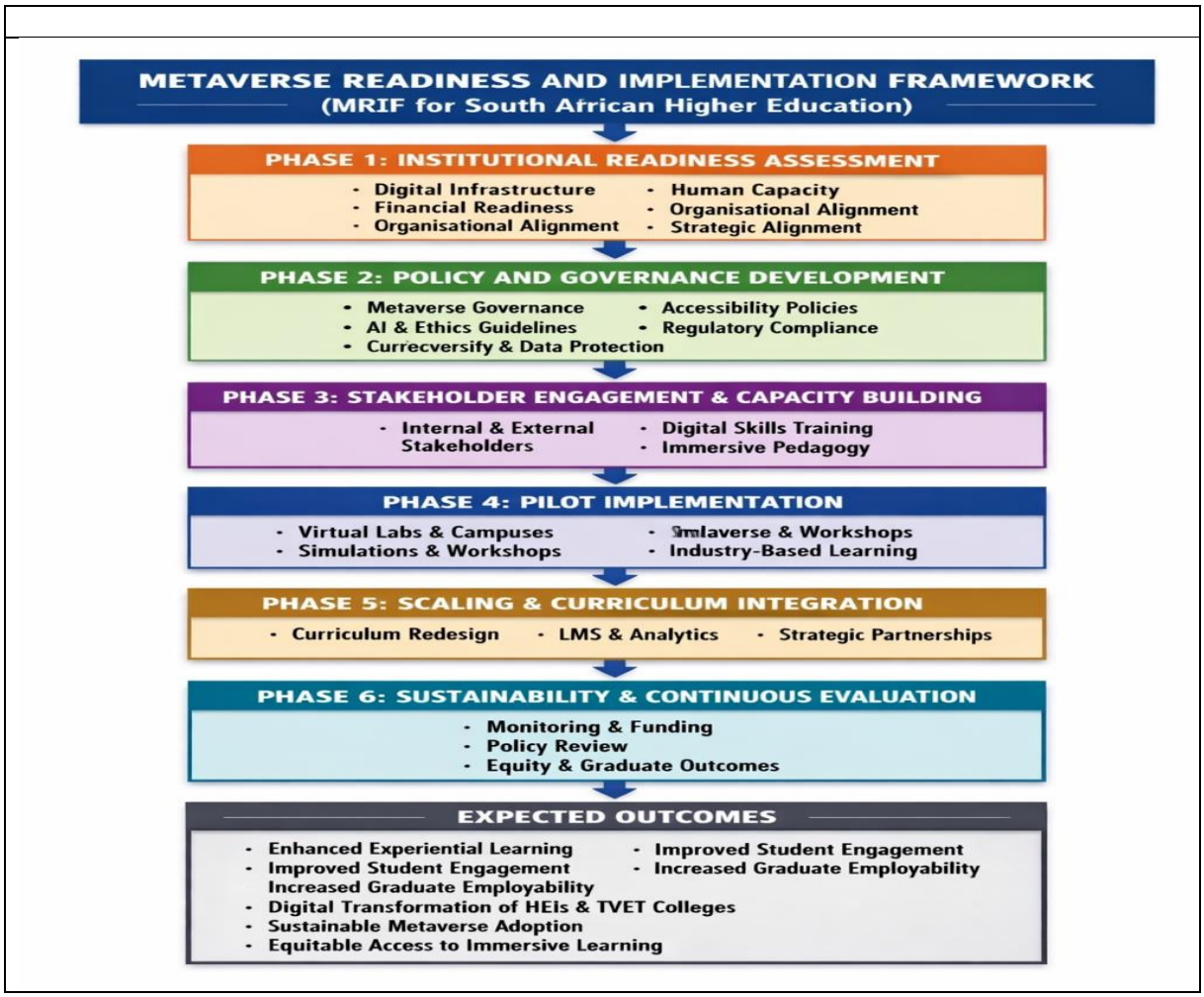


Fig. 1. Proposed Metaverse Framework
Source: Researchers Own Compilation

7. Conclusion

This study found that South African higher education institutions and TVET colleges demonstrate emerging readiness for metaverse adoption, evidenced by the increasing use of digital learning platforms, blended learning approaches, and collaborative initiatives aimed at enhancing teaching and learning. However, institutional readiness remains uneven due to infrastructure disparities, limited digital competencies, inadequate policy and governance frameworks, funding constraints, and persistent inequalities across the sector. While participants expressed strong optimism regarding the potential of immersive technologies to enhance experiential learning, student engagement, practical skills development, and access to education, they also highlighted significant challenges related to digital inclusion, cybersecurity, change management, and sustainability. The findings suggest that successful metaverse integration requires a holistic and coordinated approach that aligns technological infrastructure, human capacity development, governance mechanisms, stakeholder engagement, and equitable access strategies. In response to these findings, the study developed the Metaverse Readiness and Implementation Framework (MRIF), which provides a context-specific roadmap to guide institutions through the stages of readiness assessment, policy development, capacity building, implementation, scaling, and continuous evaluation. The study therefore concludes that metaverse adoption is both feasible and desirable within the South African higher education and TVET sectors, provided it is implemented through a phased, inclusive, and strategically governed process that promotes sustainability, innovation, and educational equity.

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Course-Specific AI TAs: A Platform Comparison for Higher Education

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Abstract

As generative AI tools increasingly spread across higher education and become more widely available, educators are confronted with a substantial decision: Which AI platform best facilitates the implementation of course-specific AI teaching assistants (AI TAs) in their courses? This study seeks to compare available options as of today by designing and evaluating three distinct course-specific AI TAs: OpenAI Custom GPT, Anthropic Claude Projects, and Google Gemini Gems, all implemented within the same college-level cybersecurity course. Each AI TA was meticulously configured with course-specific instructional objectives, lecture materials, a course syllabus, an academic schedule, and course-related resources. We assessed the following governance-relevant criteria: customization depth, ease of setup, course resource integration, interface & accessibility, multimodal capabilities, privacy & ethics controls, institutional cost, and pedagogical impact. At the time of this writing, our comparative analysis finds that Custom GPT stands out as the most fully featured no-code platform for a deeply customizable, tightly governed, shareable, course-specific AI TA deployment. Claude Project has closed the gap, particularly with the addition of Skills, though it remains more constrained in Project sharing across organizations/institutions and dynamic usage. Gemini Gems offers the strongest multimodal and Google-native integration but remains limited by upload, storage, and context-window constraints. Overall, this study offers guidance to instructors and institutions on deploying AI TAs that enhance learning experiences and outcomes while safeguarding academic integrity and promoting accessibility.

Keywords: *Course-specific AI Teaching Assistant (TA), AI-augmented Higher Education*

1. Introduction

Artificial intelligence (AI) is reshaping higher education by expanding the ways students seek explanations, practice skills, and receive feedback. Students now encounter general-purpose conversational systems as everyday academic tools, yet those systems are not designed primarily for course-grounded instruction, institutional governance, or academic integrity [1], [2]. For instructors, then, the central question is no longer whether an AI system can answer student questions. The more consequential question is whether it can function as a course-specific assistant that remains grounded in the syllabus, lecture content, and course policies; supports learning without producing graded solutions; and operates in ways that are consistent with institutional expectations for privacy, access, and oversight. These concerns have become more pressing as AI-supported tools move into mission-critical and educational settings, where system failures, hallucinations, and misuse can have consequences that extend well beyond convenience or productivity [3], [4], [5]. In higher education, the value of such tools depends not only on what they can produce, but also on whether they can be integrated into teaching in ways that are pedagogically sound, ethically defensible, and practically sustainable [6], [7], [8].

This paper examines those challenges by building and comparing three no-code, course-specific AI teaching assistants (TAs) for the same college course: OpenAI Custom GPTs, Anthropic Claude Projects with Skills, and Google Gemini Gems. All three platforms now allow instructors to define custom instructions and attach course-related materials, but they differ in meaningful ways with respect to persistence of course knowledge, sharing and access, multimodal support, and administrative controls. Our purpose is not to identify a single universal winner. Rather, we seek to clarify which trade-offs matter most when instructors and institutions select a platform for a course-specific AI TA.

This study builds directly on our earlier work on course-specific AI TAs and AI-augmented teaching [9], [10], [11]. In prior research, we developed and evaluated a course-grounded AI TA based on Custom GPT, with particular attention to implementation choices and effects on student learning [9]. Related work also examined broader pathways toward AI-augmented teaching in higher education and the practical design choices required for responsible instructional use [10]. More recently, the same design

logic has been extended to other educational contexts, including medical education, suggesting that course-specific AI TAs can be adapted across disciplinary settings while retaining the same underlying concerns about grounding, pedagogy, and governance [11]. The present study builds on that line of work by moving from a single platform case to a comparative, cross-platform analysis.

Observations from practice motivate this comparison. The educational value of an AI TA depends on grounding in the course-specific context. A helpful course assistant should begin with the course's own materials, including the syllabus, lecture slides, lab guides, research projects, and other related academic resources, before relying on external resources. Furthermore, academic integrity cannot be simply assumed. Default assistants may be helpful yet still permissive, which means support patterns and coaching strategies must be deliberately designed and implemented in line with the instructor's teaching plan and philosophy. Additionally, institutional constraints, such as licensing, device configuration, privacy protections, ethical issues, and instructor oversight, shape whether an apparently useful system can be adopted fairly and responsibly across a course or program. Therefore, the evaluation focuses on several criteria that, in our judgment, best predict classroom usefulness and institutional adoptability: knowledge capacity and persistence; internal grounding and citation fidelity; external scholarly retrieval and citation completeness; academic integrity and ethics; mobility across devices; multimodal utility; and cost and usability within the institutional setting. We intentionally do not foreground timing comparisons or decontextualized accuracy leaderboards. In this course setting, those measures were less informative than the broader question of whether a platform could function as a dependable instructional assistant under realistic teaching constraints.

This study makes three contributions. First, it provides a replicable approach to evaluating course-specific AI teaching assistants under realistic instructional constraints. Second, it offers a platform-aware analysis that links observed behavior to governance choices, including what can be achieved through no-code configuration alone and when institutions may need to migrate toward SDK or LMS-based deployments for retrieval augmentation, logging, and learning analytics. Third, it offers practical guidance for instructors and institutions by identifying the conditions under which each platform is most useful and the trade-offs that accompany those choices. In this sense, the study moves the discussion from generic chat toward governed assistance: systems that begin with the course's own voice and values, support learning without requiring completion of graded work, and fit within the institutional fabric of higher education.

2. Background and Related Work

Prior work has established the promise of AI in higher education, while also warning that pedagogical value depends on context, governance, integrity safeguards, and institutional readiness [12], [15]. More recent studies and policy analyses suggest that institutions are moving away from blanket prohibition and toward more explicit guidance on acceptable use, attribution, course-level expectations, and AI literacy [16], [19]. Within that landscape, course-specific AI TAs have emerged as a particularly useful model because they can be anchored to local materials, shaped by instructor intent, and evaluated against concrete pedagogical goals rather than generic chatbot performance [9], [10], [11]. In this study, we examine three widely used AI platforms by configuring each with the same course materials and integrity policies and then comparing their pedagogically relevant trade-offs through hands-on experiments.

OpenAI's Custom GPT feature provides one of the widely recognized no-code pathways for building a course-specific assistant. Instructors can define persistent instructions, upload course materials as knowledge, and enable additional capabilities such as web search, data analysis, and connected tools. As of today, a GPT can include up to 20 uploaded knowledge files, with each file limited to 512 MB, making the platform attractive for courses that rely on extensive lecture decks, policies, lab guides, and reference materials. A major strength of Custom GPTs is controllability. The platform allows instructors to shape tone, refusal behavior, prompting logic, and task boundaries with relatively fine granularity, which is especially useful in courses where academic integrity expectations must be explicit. Custom GPT also offers broader sharing options than the other no-code platforms examined here, including direct link sharing and managed workspace distribution.

Anthropic's Claude Projects allows instructors to define project-level instructions and upload persistent files so that students remain inside a bounded course context rather than using a general chatbot with no local grounding. Furthermore, Skills now add reusable task behavior and can be shared or provisioned in some plan contexts, which materially strengthens customization beyond simple prompt writing. However, as of today, sharing is more constrained than in ChatGPT. Claude Projects can be shared organization-wide or invitation-based within the same organization, rather than openly

distributable through a general-public-style URL. Therefore, if the instructor and students are not affiliated with the same university, they cannot share Claude Projects for AI TAs. Usage limits are also dynamic and depend on factors such as load, conversation length, model use, and attachments. Even with those constraints, Claude remains a compelling option when instructors want a fast setup, a strong integrity posture, and course-grounded behavior without extensive prompt hardening.

Google's Gemini Gems lets instructors define a reusable assistant with custom instructions and attached materials, and Gemini is particularly effective when students need help interpreting screenshots, diagrams, figures, or mixed-media inputs. Gemini's practical constraints are different from those of ChatGPT and Claude. Google's current documentation emphasizes file and storage upload limits, as well as rolling usage limits, rather than presenting Gems as an unrestricted, persistent knowledge environment. Gemini Apps support file-backed interaction, but large or numerous uploads can exceed context windows or reduce response quality, and the platform explicitly warns that oversized uploads may cause missed details or weaker cross-document connections. Gemini also supports sharing, including viewer and editor roles, but attached files become visible to users with access, which raises governance questions when instructors work with copyrighted, licensed, or sensitive course materials. A further limitation for this use case is that Gems cannot currently be used with Gemini Live, so voice-based interaction does not extend to the custom course Gems. As with the other no-code platforms, built-in instructor-side logs are limited.

At the time of writing, several other popular AI platforms are relevant to higher education, including Grok (xAI), Microsoft Copilot, Mata AI, and others, but none currently offer the same combination of usability, course-specific grounding, and instructor-ready no-code deployment as Custom GPTs, Claude Projects, and Gemini Gems. We therefore exclude them from the comparative analysis in this study.

3. Building Course-Specific AI TAs (Same Knowledge, Different Platforms)

We built three course-specific AI TAs intended to serve the same instructional purpose across different platforms. The goal was not to optimize each platform separately, but to hold the teaching intent constant and evaluate the capabilities and constraints across Custom GPT, Claude Projects, and Gemini Gems. Our priorities were straightforward: make the setup replicable, keep the instructions clear, and avoid design choices that would create uneven access for students.

3.1 Study Setup and Key Constraint

We developed three course-specific AI TAs for the same course using the same course description, custom instructions, syllabus, lecture materials, and related resources. However, there is a critical platform-level constraint in one of the AI platforms. During our study period, the Gemini configuration we used limited the number of uploaded files in persistent use to 10, whereas Claude Projects and Custom GPTs could accommodate the full set of 21 course materials. As a result, the Gemini TA included only the syllabus and core lecture decks, whereas the Claude and Custom GPT versions also included lab manuals, external course resources, relevant research articles, and other academic resources. This directly affected how fully each TA could stay grounded in the course. In our setting, that difference became one of the most important practical limitations of Gemini.

3.2 Pedagogical Goals

The three TAs were built around the same instructional goals. First, they were expected to clarify concepts from lectures and labs. Second, they were expected to support problem-solving without giving away graded answers. Third, they were expected to direct students back to the relevant course materials rather than providing generic advice. Fourth, the TA was intended to function more like a guided study partner than a simple answer provider. That distinction has become increasingly important in recent work on generative AI in higher education, especially in discussions of student agency, tutoring, and ethical use [19], [20].

3.3 Standardized Instruction Block

Across all three platforms, the AI TAs were given the same operating logic. Accuracy was prioritized over speed. If a prompt was unclear, the AI TA was instructed to ask clarifying questions before answering. It was instructed to search the persistent course knowledge first, including the syllabus, lecture slides, lab materials, and related course materials, before producing a response. If that

knowledge was insufficient, it was instructed to request the missing information from external sources and cite them clearly. When students attached PDFs or images, the AI TA was expected to interpret them and explain what they showed. It was also encouraged to ask reflective follow-up questions, recommend credible external resources when appropriate, and defer questions about policy, schedule, and requirements to the syllabus and other course materials.

3.4 Optional SDK / External Tools

This study focuses on no-code classroom feasibility: how quickly an instructor can launch a usable AI TA, how much integrity support appears by default, and how much can be done without development support. Once an API layer is added, results begin to depend on engineering choices such as retrieval design, chunking strategy, tool orchestration, interface design, logging architecture, and caching. They can easily overshadow the out-of-the-box differences between platforms. For that reason, including SDK-based implementations in the present study would have made the findings harder to interpret. It would also have introduced additional data governance and research complexities, including decisions about storage, consent, retention, deletion, and institutional review. Therefore, we consider SDK and external tools as an important future path rather than part of the baseline comparison in this study.

4. Results and Comparative Analysis

Following the development of AI TAs for the same cybersecurity course across the three AI platforms described in the previous sections, we conducted a systematic evaluation and comparative analysis. This analysis examined multiple critical dimensions, including Customization Depth, Ease of Use, Course Resource Integration, Interface and Accessibility, Multimodal Capabilities, Privacy and Ethical Controls, Institutional Cost, and Pedagogical Impact. The results of this comparative evaluation are summarized in Table 1.

Table 1. Comparative Analysis of AI TA Platforms

Criteria	ChatGPT (Custom GPTs)	Claude (Projects + Skills)	Google (Gemini Gems)
Customization Depth	Very High — Persistent instructions, knowledge files, optional actions/apps, and version history.	High — Persistent project instructions/files; Skills extend customization but add governance and security caveats.	Moderate — Instructions, file-backed context, previewing, and sharing, but fewer explicit control layers.
Ease of Setup	Moderate — Streamlined builder, but strong performance still depends on careful prompt design and testing.	High — Simple workflow: create project, upload files, add instructions, and use persistently.	High — Fast setup, simple previewing, and optional AI-assisted instruction rewriting.
Course Resource Integration	Strong — Knowledge files are designed for persistent reference during conversation across common file types.	Strong, with format caveats — Supports multiple file types, but PDFs are best when visual elements matter; non-PDF documents are treated mainly as text.	Moderate — File-backed knowledge works well, but storage, upload, and large-file caveats are more prominent.
Interface & Accessibility	Strong — Private, link-based, workspace, and broader sharing options depending on plan and admin settings.	Moderate — Project sharing is mainly organization-wide or invite-only; Projects do not offer the same general link-sharing model as ChatGPT GPTs.	Strong — Available on the Web, mobile, and Workspace side panel; supports private, organization, link, or public sharing depending on account settings.
Multimodal Capabilities	Strong — Supports documents, spreadsheets, images, code, Web search, image generation, voice chat, and data analysis options.	Moderate — Good document/image support; visual interpretation is strongest in PDFs, weaker in non-PDF documents with embedded images.	Very Strong — Broad support for documents, spreadsheets, images, videos, code repositories, and data visualization.
Privacy & Ethics Controls	Strong — Workspace restrictions, compliance availability, and analytics in managed deployments.	Strong — Clear organizational boundaries for Projects and collaboration controls, but Skills introduce	Moderate — Admin controls and enterprise protections exist, but shared Gems expose instructions and

		prompt-injection and data-exfiltration risks.	uploaded files to authorized users.
Institutional Cost	Variable — Paid access and institutional governance options exist, but institutional licensing and entitlements must be verified locally.	Variable — Plan access is clear, but institutional licensing and entitlements must be verified locally.	Variable — Feature access depends heavily on Workspace and Google AI licensing; Institutional licensing and entitlements must be verified locally.
Pedagogical Impact	High — Best fit for tightly guided course assistants that require strong behavioral guardrails and durable reference to course materials.	High — Particularly strong for writing-intensive, discussion-based, and reflective learning support.	Moderate — Especially useful when multimodal course materials or Google Workspace integration are central.

As of April 2026 (at the time of this writing), our comparative analysis finds that Custom GPT stands out as the most fully featured no-code platform for a deeply customizable, tightly governed, shareable, course-specific AI TA deployment. Claude Project has closed the gap, particularly with the addition of Skills, though it remains more constrained in Project sharing across organizations/institutions and dynamic usage. Gemini Gems offers the strongest multimodal and Google-native integration but remains limited by upload, storage, and context-window constraints.

5. Recommendations: When to Choose Which Platform (Decision Matrix)

Selecting among Custom GPTs, Claude Projects, and Gemini Gems depends less on which platform is "best" in the abstract than on which platform best fits the instructional scenario, course-specific support, governance requirements, and interaction mode of a given course. Accordingly, Table 2 presents scenario-based recommendations drawn from our comparative analysis and current vendor documentation. Rather than designating a universal winner, we align each platform with the use cases for which its documented capabilities are presently the best fit.

Table 2. Decision Matrix for Selecting a Course-Specific AI TA Platform

Instructional Scenario	Primary Choice	Notes
Fast, low-friction no-code launch with strong governance controls	Claude Projects	Claude Projects provide a simple no-code workflow: create a project, upload files, add project instructions, and keep chats scoped to that project. Skills can extend functionality, but they are optional and may require admin enablement or added security review.
Large, persistent course knowledge base (labs, policies, articles, slide decks)	Custom GPTs or Claude Projects	ChatGPT Custom GPTs support persistent knowledge files and no-code configuration. Claude Projects also provide a persistent project knowledge base and document automatic RAG (Retrieval-Augmented Generation) scaling for large project knowledge.
Heavy visual, screenshot, figure, and diagram workflows	Gemini Gems	Gemini is the strongest fit when course interaction depends heavily on multimodal inputs such as images, charts, screenshots, videos, spreadsheets, or code repositories.
Voice conversations with the TA	Custom GPTs	OpenAI explicitly documents voice conversations with GPTs. Claude also supports full voice conversations. Gemini Gems are not currently usable with Gemini Live.
Current-information retrieval, external links, and source-grounded answers	Custom GPTs or Claude Projects	ChatGPT Custom GPTs can enable Web search as a built-in capability. Claude documents live web search with citations and direct URL fetching when web search is enabled.
Auditability, analytics, and institutional oversight	Custom GPTs	OpenAI currently documents the clearest GPT-specific managed-workspace governance stack, including RBAC (Role-based Access Control), sharing controls, action-domain restrictions, compliance visibility, and GPT-level workspace analytics. Claude also now documents meaningful Team/Enterprise analytics and exports, but the GPT-specific governance model is most explicit in OpenAI's Enterprise/EDU documentation.

Broad student-facing sharing by link or public discovery	Custom GPTs or Gemini Gems	ChatGPT supports private, workspace, link-based, and GPT Store/public sharing depending on plan and admin settings. Gemini supports private, organization, anyone-with-link, or public sharing depending on account type and admin controls. Claude Projects are primarily organization-visible or invite-based rather than generally public project links.
Instructor/TA collaboration inside an organization-scoped workspace	Claude Projects	Claude Projects are especially well suited when instructors and TAs need a shared, persistent workspace with project knowledge, project instructions, and organization-scoped visibility settings. Gemini Gems supports collaboration via the extended Google ecosystem.
Cost and usability under campus provisioning	Locally dependent; verify before recommending	This category remains institution specific. Platform availability, sharing permissions, model access, and governance features depend heavily on local licensing, admin settings, and procurement terms.

Taken together, the scenario matrix summarized in Table 2 suggests that no single AI platform can be regarded as uniformly optimal across instructional scenarios. Rather, each appears to support a distinct area of comparative advantages and is constrained by pedagogical purpose, interaction design, and governance requirements. In contexts where persistent course-specific materials, flexible student-facing availability, voice interaction, and the possibility of later migration to a more formally managed institutional environment are central, the OpenAI ecosystem appears especially well aligned. By contrast, Anthropic's project-based workflow is particularly well suited to cases in which instructors prioritize rapid no-code setup, organization-scoped collaboration, and relatively bounded instructional use, although these advantages should be considered alongside its more limited sharing model and the additional governance considerations associated with enabling Skills. Google's offering, in turn, is most compelling where instructional activity depends heavily on multimodal interaction, such as screenshots, figures, diagrams, charts, video, or other visually rich course materials, especially when those workflows are already embedded in Google's ecosystem. More broadly, the matrix indicates that platform selection is most productively understood not as a simple comparison of model quality, but as a consideration of instructional and institutional fit. Accordingly, the relevant evaluative standard is less about which system performs best in the abstract than which one most appropriately matches the course's knowledge structure, sharing requirements, interaction mode, and oversight context.

As a result, the matrix suggests three practical conclusions. First, Custom GPT is the strongest choice when the instructional priority is a tightly governed, shareable, knowledge-grounded course assistant that may later require stronger institutional oversight or analytics. Second, Claude Projects is particularly appropriate when instructors prioritize setup speed, rapid no-code deployment, and conservative instructional behavior, provided that its more limited Project-sharing model and dynamic usage constraints are acceptable within the same institution. Third, Gemini Gems is best understood not as the most general platform, but as the strongest option when the course design depends heavily on multimodal interaction, visual explanation, or Google Workspace alignment. Therefore, we emphasize that the selection of the AI platform should be treated as a pedagogical and governance decision based on the course objectives and related learning activities rather than merely a model performance.

6. Conclusions and Future Work

In this study, we compared three no-code AI platforms for course-specific AI TAs, using OpenAI Custom GPTs, Anthropic Claude Projects with Skills, and Google Gemini Gems for the same cybersecurity college-level course, and we evaluated them against the pedagogical and governance criteria. While the findings show that no single platform is uniformly superior across educational scenarios, each AI platform reflects distinct trade-offs and is effective in specific instructional conditions. Overall, as of today, Custom GPT offers the greatest behavioral management, customization details, accessibility, and the clearest path toward institutional oversight, making it the most suitable choice when governance and shareability are primary concerns. Claude Projects may provide the rapid no-code deployment and the strongest collaboration features, while its more restricted sharing model limits cross-institutional teaching, especially when the instructor and students are not within the same institution supported by the Claude service. Gemini Gems is the most capable platform for multimodal interaction, especially within the Google ecosystem, but its upload constraints (e.g., limited course knowledge space) and the exclusion of Gems from voice interaction hinder its usefulness as a general-purpose course-grounded assistant. More broadly, these findings reinforce a conclusion from our earlier work on course-specific

AI TAs [9], [10], [11]: AI platform selection is not merely a matter of model performance. It is a pedagogical and governance decision, and instructors are best served by anchoring it in the actual knowledge structure, interaction patterns, course-specific learning activities (e.g., labs, research projects, discussions, etc.), and oversight requirements of their course.

This study directly leads to several directions in future work. First, the accuracy and reliability of each AI platform's knowledge retrieval (i.e., response to queries) need to be formally evaluated. Future work should benchmark each platform against course-specific ground-truth queries to identify where retrieval quality degrades, where hallucinations occur, and how error rates differ across platforms. In a mission-critical educational context such as medicine and cybersecurity, this evaluation is critical. Second, scalability across AI platforms remains a challenge. As AI platforms update their capabilities, tools, storage limits, underlying models, and pricing structures, the trade-offs summarized in Tables 1 and 2 will shift, and the framework developed here should be re-evaluated at regular intervals to remain current. Third, instructor monitoring and auditability represent persistent gaps across all available no-code platforms. For instance, without access to query-response logs, instructors cannot verify if the AI TA behaved appropriately, identify boundary failures, or detect misuse. Therefore, future work should examine SDK-integrated deployments that enable logging, audit trails, and instructor-facing dashboards, building on the governance considerations we have identified here. Finally, extending the cross-platform comparison to additional disciplines, including medicine, law, arts, and engineering, would test whether the trade-offs observed in a cybersecurity context hold across domains with different precision requirements, content structures, and student interaction patterns, building on the cross-disciplinary AI TA framework.

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Can AI Learning Systems Build the DeepTech Workforce? A Model for Aligning Education, Labor Markets, and Industry Demands

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Abstract

The arrival of AI is influencing major changes in global economies, yet the talent development ecosystem leveraging AI systems has lagged behind. Consequently, significant gaps in productivity gains persist owing to the failure of the talent development ecosystem to keep pace. This paper argues for a strategic, structured and systematic approach to transform outdated, inflexible and largely inaccessible learning and training models that dominate contemporary workforce development systems. To bridge this scholarly lacuna, the researcher uses a sociotechnical systems perspective and investigates whether AI-supported learning systems can be instrumental as workforce infrastructure. The major discussions in the paper center on workforce development related to deeptech technologies including quantum computing, Internet of Things, nuclear fusion, genetics, and advanced manufacturing. The study adopts a conceptual synthesis, which is informed by workforce development policy literature. The literature review provides insights into structural bottlenecks in education to employment channels and enhances understanding of effectiveness and limitations of learning pathways. The paper evaluates modes such as adaptive learning platforms, skill and competence-based frameworks, and micro-credential ecosystem architecture. Moreover, the analysis underscores how each mode works and differs in facilitating deep-tech skills acquisition. In the final part of the paper, insights enable development of a model for AI-enabled learning systems. The proposed framework is developed through the integration of three core components. First, an intelligence layer maps deep technology competencies based on labor market data. Second, an adaptive learning engine recommends learning pathways. It considers different factors such as learners' backgrounds and changing industry needs. Third, a micro-credentialing system verifies and stores credentials that can be recognized by both employers and educational institutions. Another layer is based on overarching themes like ethics, human factors, data privacy, facilitator's role, equity and governance in the model. This research provides insights to policymakers and other stakeholders to leverage AI not as a system of content delivery but as a learning system and workforce development infrastructure.

Keywords: *Artificial Intelligence in Education; DeepTech Workforce Development; Adaptive Learning Systems; Micro-Credentials; Education–Labor Market Alignment*

1. Introduction and Context

This paper synthesizes and analyzes the emergence of two significant contemporary trends: the growing use of artificial intelligence (AI) in education and workforce development, and the rapid expansion of the deep-tech sector.

Deep Technologies (Deeptech) are defined as breakthrough technological discoveries or engineering/scientific innovations. Their main features are technological uncertainty and long development cycles. These technologies have the potential to reshape economic structures, industries and societies [1].

However, the current system of educational institutions, training providers, and skill assessment frequently remain disconnected from rapidly evolving labor market demands, despite major technological progress. This problem leads to skill shortages in the deeptech sectors despite significant financial focus from the policy-makers and private sector on education and training [2], [3].

These technologies include AI, quantum computing, advanced manufacturing, biotechnology, nuclear fusion, robotics, clean energy, and the Internet of Things (IoT). These technologies are disruptive and knowledge-intensive by structure. As a result, they depend on a highly skilled workforce. Also, for these sectors adapting and responding to the fast-changing technological environments is essential. These challenges arise from inefficiencies and coordination problems in the ecosystem. The accumulation of

these problems makes the integration of learning frameworks with changing industry needs challenging. Several reasons can explain as to why these problems exist.
Based on my analysis, three distinct factors are integrated to address the afore-mentioned problems. They form the basis of the framework:

1. Labor market intelligence, however, it tends to be fragmented and generally lacks any structured approach to directly and consistently inform curricular development.
2. Learning journeys, but the challenge with them is that they tend to be too standardized and rigid despite the fact that career paths have evolved to be diversified.
3. Credentialing mechanisms, but they face major interoperability problems and it is difficult to convert or transfer recognition of skills across sectors and geographies.

The paper highlights the effective use of AI as a workforce infrastructure and not only as educational technologies. The conceptual model is based on socio-technical systems theory and the framework brings three main factors together into a unified workforce development ecosystem, namely; labor market intelligence, adaptive learning, and credential verification.
The key question addressed in the paper is how can AI-based learning systems operate as workforce infrastructure for deep-tech talent development?

2. Literature Review

Governments around the world have pursued different approaches and initiatives to support deeptech workforce development. Policies in the United States have emphasized industry-led workforce initiatives and public-private partnerships to build talent. The European Union has focused on providing broader digital skills. It also relies on lifelong learning strategies. It launched initiatives such as the Digital Education Action Plan in this regard [4]. The SkillsFuture program from Singapore is another important national initiative. But it is more integrated and links the factors like labor market forecasting, credentialing, and continuous workforce development [5]. Although there are institutional and structural variations among these countries, they share a common challenge. Their educational systems, and credentialing systems in particular, are unable to keep pace with fast-changing technological dynamics. OECD shows similar trends in their reports. Their findings identify gaps between labor market requirements and workforce readiness in the developed countries [6], [7]. Overall, the takeaways from these reports indicate that successful workforce development depends less on isolated interventions but more on continuous and systematic coordination between various stakeholders such as educational institutions, employers, policymakers, and credentialing organizations.
Policy reports mention talent shortages as a major challenge in the deep-tech sector. The World Economic Forum [8] projected an increase in job demands in deeptech fields like artificial intelligence, data analytics, cybersecurity, robotics, and advanced technologies. However, it also flagged a shortage of qualified talent in these fields as a major challenge. OECD skills assessments and the National Academies' analysis of AI and the future of work [9] reports have also raised similar concerns.
There are different approaches to workforce development. Each has its own advantages and limitations. For example, adaptive learning systems provide personalization through learner profiling, competency mapping, skills-gap identification, and individualized recommendations [10]. However, their effectiveness depends on the quality of data and the governance involved. On the other hand, skills or competence-focused frameworks lead to better alignment between instructional outcomes and labor market demands. But the biggest challenge facing them is standardization. Likewise, micro-credential ecosystems have the clear advantage of flexible and lifelong learning pathways but fragmentation and limited interoperability across institutions prove to be major obstacles to their efficacy [11]. Collectively, it can be deduced from these findings that deep-tech talent shortages are a systematic coordination problem involving interconnected dimensions.
The literature provides strong insights on major themes connected in this study namely: AI-supported learning systems, workforce development, labor market intelligence, and skills-based credentialing. Most studies on AI-supported learning have illustrated the instructional effectiveness and enhanced learning outcomes [10], [12]. Likewise, workforce development literature on use of AI focuses on its instrumental role in labor market transformation and emerging skill demands [2], [3], [7]. The scholarship on micro-credentials underscores alternative credentialing pathways and lifelong learning opportunities [11]. However, these domains largely remain independently studied. There is limited attention devoted to analysis of gaps in the overall workforce development - particularly using the factors such as labor market intelligence, adaptive learning systems, and credential ecosystems. This paper addresses this gap and introduces an integrated approach for deep-tech talent development rooted in sociotechnical systems theory.

2.1 Sociotechnical Systems Theory

I derive the theoretical foundations of the framework from Sociotechnical Systems (STS) theory. Advanced by Trist and Bamforth [13], the theory is relevant to the thesis as it asserts that the combined impact of social and technical systems enhanced organizational effectiveness. It dispels the false assumption that technological innovation alone can generate sustainable transformation. It has to be complemented by various social dimensions of evolution such as governance structures, institutional arrangements, and human practices.
I apply this model to the workforce development. It is a pertinent model because of its explanatory power of learning systems. And it argues that technological systems cannot be conceived solely as educational technologies for workforce development. More important is the fact that they are embedded within broader ecosystems and involve various stakeholders such as learners, educators, employers, policymakers, credentialing organizations, and technological infrastructures.
An emerging body of scholarship tends to advance the STS theory to digital transformation and AI-supported systems [14]. These studies confirm that efficacy of AI systems is fully achieved when they are complemented by the organizational and institutional processes and policies. Operating them in isolation and viewing them as solely technical interventions do not yield the same level of effectiveness.

2.2 Deep-Tech Workforce Development

Because deeptech industries are driven by scientific discovery and engineering innovation, they are different from traditional technology sectors. These industries generally face talent shortages due to fast-changing skills requirements and limited educational capacity [8], [6].
Research highlights an increasing demand for competencies related to data analytics, quantum information science, biotechnology, advanced robotics, and cybersecurity [15]. However, educational institutions generally are not able to update curricula as fast as these technologies evolve. As a result, the learners may acquire basic knowledge but lack the market-ready competencies [6]. Nowadays, the emphasis on adopting flexible and responsive mechanisms to workforce development is strengthening. Some of the emerging domains in this area include competence-based recruitment, micro-credentials, and lifelong learning models.

2.3 AI-Supported Learning Systems

Learning systems supported by AI have emerged as a useful educational innovation. Personalized and adaptive learning platforms as well as other platforms operating in the adjacent space such as intelligent tutoring systems and learning analytics tools rely on learner data to personalize the learning experience and provide individual assessment, feedback and even tailor the content according to needs and choices. Applications of AI in education have been documented in domains such as adaptive learning, intelligent tutoring, profiling and predictive analytics, assessment and evaluation, as well as for individualized learning support [16].
Research shows that adaptive systems improve learning outcomes. It is particularly true for structured learning environments. Competence mapping is easier and skill levels can be monitored in these environments [12]. However, the existing literature is limited on workforce and talent development outcomes. Consequently, a research gap exists on learning efficiency of how AI-supported systems in their support for workforce development objectives.

2.4 Skills-Based Credentialing

Micro-credentials and competency-based systems have become common in recent years. They are alternatives to traditional degrees and diploma-based qualifications. They provide evidence of the competencies that learners have gained through focused and short-term learning. Also, they facilitate learners' lifelong educational trajectories.
In spite of these benefits, several challenges remain related to these recognition and assessment systems. One of the main concerns is that they are often fragmented and there is no standardization. Employer recognition structures are also inconsistent. Limited interoperability between institutions and regions is also a major issue [11].

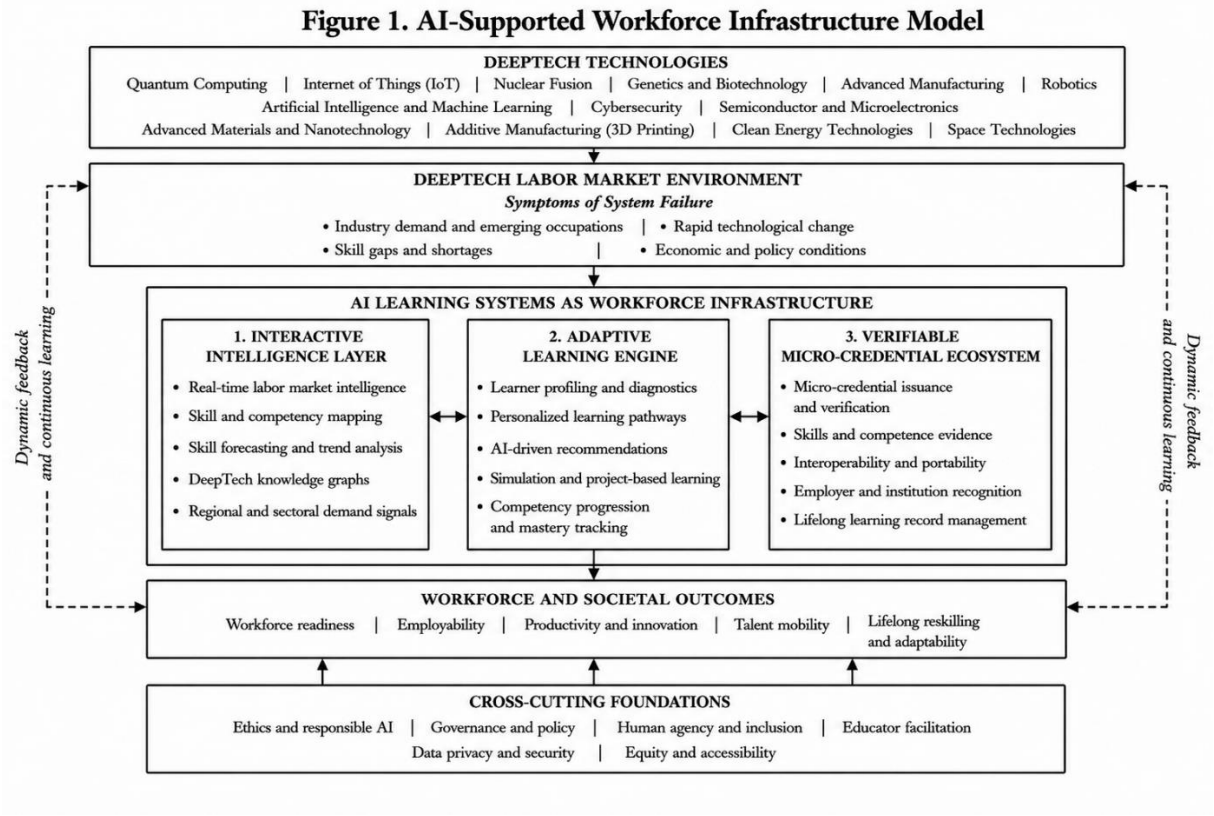
3. Methodology

I use conceptual synthesis as a methodology in this paper. Through this approach, I integrate different dimensions identified in workforce development literature and policy documents. These sources were selected based on their focus on AI-supported learning, talent development, and credentialing systems. Following this, I performed a thematic synthesis to identify recurring patterns, key bottlenecks, as well as implications. The findings led to the development of the framework.
Based on my analysis and synthesis, three different themes emerged: mismatch between educational provision and labor market demand, increasing variations in learner pathways and skill development needs, and fragmentation across credentialing systems. These observations point towards a missing integrated workforce infrastructure that can address these three concerns.

4. Framework Development

The main contribution of my work in the paper is the development of the AI-Supported Workforce Infrastructure Model. This unified framework illustrates workforce readiness in deep-tech sectors. It also builds the framework through the factors that were identified in the research: effective functioning of labor market intelligence, adaptive learning pathways, and interoperability of credential ecosystems.
There is another layer in the framework, which is based on crosscutting dimensions such as ethics and responsible AI, governance and policy, human agency and inclusion, educator facilitation, data privacy and security and equity and accessibility. The framework also adds dynamic feedback and continuous learning as important features between deeptech labour market environment and workforce as well as social outcomes. The process of the AI-supported workforce development mechanisms will be incomplete without these factors. In fact, there can be adversarial outcomes if these dimensions are overlooked and not focused properly.

Figure 1. AI-Supported Workforce Infrastructure Model



Based on its emphasis on the Sociotechnical Systems Theory, the paper argues that AI-supported workforce development cannot be analyzed in isolation. It should not be considered simply as an educational, technological, or labor market issue. Instead, most talent shortage challenges arise from dynamic interaction of institutions, technological infrastructures, policy milieu, labor market requirements and pressures, credentialing systems, and educational ecosystems. Therefore, the paper contends that deeptech talent shortages are systematic failures. And AI has the potential to operate as infrastructure

for repairing those failures. Access to advanced technologies or educational opportunities are important. But the extent to which these interconnected dimensions interact as an integrated whole is more important. This perspective frames the issue differently as a systems problem. It suggests that systematic alignment is a pre-condition for addressing deep-tech talent shortages. This alignment should involve all stakeholders including educational providers, employers, policymakers, and AI-enabled learning infrastructures.

5. Implications for Policy and Practice

The model presents clear guidelines on the importance of prioritizing real-time intelligence capabilities in the deeptech labor market. It also offers recommendations on standardization of digital credentialing. It can be inferred from the discussion that the policymakers must enable conditions for collaboration between education systems and training providers, employers, technology companies, and policy actors. The model also provides practical recommendations to educational institutions. It shifts the focus away from rigid curricular structures towards more flexible architectures. By doing so, it presents a systematic path for educational institutions to adapt to the demands of industries with AI prevalence.
For technological companies and other related employers, the model provides a tool to better communicate emerging competency requirements. As a result, they play a more proactive role in the process of workforce development. It is important to note that the framework does not frame AI as a replacement of educators. It, in fact, re-centers the discussion on the role of educators as facilitators and mentors in talent development.
This framework is conceptual in nature in its present form. Future research can explore its application throughout different deep-tech sectors. It can also be analyzed in different geographical contexts and educational systems. One dimension can be the empirical validation of the framework. Other areas can be on assessment of role of human agency, governance challenges, data privacy considerations, and equity implications.

6. Conclusion

The fast adoption and deployment of AI systems reveals various limitations in the contemporary workforce development systems. The major problem is that current educational structures along with the credentialing systems are not equipped and prepared to keep pace with the changing market realities. Consequently, the economies worldwide face serious skill shortages and underutilization of human talent. This paper calls for rethinking AI-supported learning systems as educational technologies and workforce infrastructure engines at the same time. The AI-Supported Workforce Infrastructure Model is based on insights from the Sociotechnical Systems Theory. The framework brings together labor market intelligence, personalized learning pathways, and credential systems. The work is valuable for the emerging scholarship on the topic of deeptech workforce. It shifts attention from AI, which is conceived as a content delivery mechanism. The discussion in the paper reconceptualizes it as an infrastructure for integrating learning, credential systems, and employment dynamics. Future research should empirically examine the hypothesis in different deep-tech sectors and national contexts. Moreover, special attention should be laid on equity, governance, and sustainable workforce development. As deep-tech industries are expanding, the key problem in the future is not whether AI can facilitate workforce development. Based on the proposed model, it will be how institutions can strategically optimize and manage AI-enabled systems for better adaptation and inclusiveness of talent development ecosystems.

AI Use Declaration

All research, conceptualization, analysis and synthesis are author’s own intellectual contribution. AI is used exclusively for editing and diagram construction. The author takes full responsibility for the content and declares that all materials including text and image content and citations are thoroughly verified.

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Reclaiming Pedagogical Agency: The EDEH AI Squad's Main Drivers Framework for Responsible AI Adoption in European Education

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Abstract

In response to the unregulated adoption of artificial intelligence (AI) in European schools, and to address the region's lag behind global technology leaders, the European Commission established the European Digital Education Hub (EDEH) as part of the Digital Education Action Plan (DEAP, 2021–2027). Between October 2025 and January 2026, the EDEH AI Squad — a group of 45 experts selected from across Europe — met online and in person to develop a Main Drivers Framework for the responsible adoption of AI in education. The framework identifies four interconnected drivers: Teacher Training in the Age of AI; Teachers as Co-Designers of AI; Public-Private Partnerships; and Data Literacy in the Age of AI. Drawing on current scholarship and UNESCO guidance, it emphasises a human-centred rather than technocentric approach to AI integration, and is designed as a modular toolkit allowing stakeholders to use each driver independently or in combination. This paper presents the framework's architecture, details the sub-group work on conditions for designing AI courses, analyses the structural tensions inherent in AI adoption across European education systems, and formulates actionable recommendations for policymakers, institutions, and educators.
This paper reflects the views of the author and the EDEH AI Squad. It does not represent the official position of the European Commission.

Keywords: *Artificial intelligence in education; responsible AI adoption; teacher agency; data literacy; public-private partnerships; European Digital Education Action Plan*

1. Introduction

The integration of artificial intelligence (AI) into educational systems has emerged as one of the defining policy challenges of the current decade. European governments and supranational institutions are confronted with two interrelated challenges. Firstly, they must address the persistent structural technological lag relative to global leaders. Secondly, they are tasked with the management of the unregulated use of AI tools by students and teachers across member states. The issue is further compounded by the fact that a significant proportion of AI tools currently employed in educational settings were not originally developed for pedagogical purposes. Instead, these tools have been adapted or repurposed for learning purposes, frequently without the incorporation of appropriate pedagogical safeguards or alignment with the objectives of the curriculum [1].
It is within this policy context that the European Commission established the Digital Education Action Plan (DEAP) 2021–2027, a comprehensive framework providing networking opportunities and institutional instruments for the responsible adoption of digital technologies in education. The European Digital Education Hub (EDEH) was established by the Commission as part of the DEAP. This collaborative platform now comprises more than 7,000 members drawn from across the educational ecosystem. The EDEH is responsible for the organisation of thematic working groups, which are referred to as *squads*. The remit of these squads is to examine specific dimensions of the future of digital education.
In response to an open call launched in September 2025, the EDEH AI Squad was formed and worked from October 2025 to January 2026. Comprising 45 selected members from across Europe spanning education and training, policy, research, learning design, EdTech, and related fields, the squad collaborated primarily online through twice-monthly plenary meetings, complemented by regular working sessions in four sub-groups. A face-to-face workshop was held in Brussels in November 2025. The output of this collaborative process is the Main Drivers Framework, which identifies four interconnected drivers: Teacher Training in the Age of AI; Teachers as Co-Designers of AI; Public-Private Partnerships; and Data Literacy in the Age of AI. The framework was explicitly designed to prioritise a human-centred

approach in keeping with current scholarship [1] and UNESCO guidance [2]. It is intended as a modular toolkit: each driver corresponds to a toolset that can be used independently or combined with others depending on the stakeholder's role, priorities, and starting point.
The paper sets out to explore how the proposed framework's architecture and rationale can address the conditions for designing AI courses while accounting for the structural tensions inherent in European educational systems. It also seeks to identify actionable recommendations for policymakers, institutions, and educators.

2. The Main Drivers Framework: Architecture and Rationale

The integration of responsible artificial intelligence in education can be considered analogous to the construction of a temple resting upon complementary foundations. In order to facilitate the successful integration of artificial intelligence in this field, there is a requirement for distinct but complementary structural supports that are able to reinforce one another. The Main Drivers Framework identifies four such supports. Of particular note is the non-exclusive nature of the drivers' hierarchy: Data Literacy in the Age of AI functions as a transversal thread that connects and underpinns the other three, since data underpins how AI systems function and how their impacts are understood and governed.

2.1 Closing the Professional Development Gap

Teacher professional development in AI has consistently lagged behind the deployment of AI tools in classrooms. To address this, the squad's first driver aims to equip educators with the skills, confidence, and critical awareness needed to understand both the potential and the risks of AI tools before adopting them for classroom use [3]. The driver is built around four pillars: Pedagogical Integration and Learning Design; Foundations, Policy and AI Literacy; Accessibility, Sustainability and Professional Development; and Classroom Practice, Tools and Implementation.
Concretely, the driver produced an advisory report for the European Commission's annual State of AI in Education assessment, a set of guidelines for building AI courses for teachers, and an example course on pedagogical integration and learning design [4]. These outputs are designed to be actionable and replicable across different national educational systems.

2.2 Repositioning Teachers as Co-Creators

AI tools designed without teacher input tend to fail in real classrooms or cause unintended harm, reproducing misalignments between technological capability and classroom reality [5]. Addressing this, the squad produced a coherent four-part mini-pack: a needs analysis explaining why teacher co-design is essential; case studies and a journey map showing what meaningful co-design looks like in practice; a quick partnership checklist structuring collaboration before, during, and after the co-design cycle; and a teacher competency map clarifying what capacities are needed for effective co-design. These instruments reposition educators from end-users to co-creators of AI tools, ensuring that pedagogy, inclusion, ethics, and safety are embedded from the outset [6].

2.3 Governing the Market: Public-Private Partnerships

Pedagogically principled AI integration cannot be sustained without restructuring the relationship between public educational systems and private EdTech providers. To this end, the squad developed Power, Priorities & Pitfalls, a card-based simulation game that enables educators, school leaders, SME owners/developers, and policymakers to explore the real trade-offs in AI-powered public–private partnerships. The game addresses four critical themes — Trust and Quality Assurance, Funding and Sustainable Investment, Governance and Regulation, and Market Fragmentation — through four distinct stakeholder perspectives. It can be deployed in policy labs, conference workshops, system strategy meetings, and training programmes.

2.4 Establishing a Shared Conceptual Vocabulary

Data literacy serves as the pivotal connecting element among all three drivers: it makes teacher training more meaningful, co-design more reliable, and partnerships more balanced. The fourth driver produced two complementary sets of resources: guides for teachers supporting them in learning foundational data and AI concepts, and teaching scenarios and activities for different age groups (8–12, 12–16, 15–19,

and across levels) providing ready-to-use classroom materials. Among the concrete outputs are a practical glossary on data and AI, a traffic-light classification system for classroom data practices (DO / ONLY IF / DON'T), and an AI-assisted guide to data literacy lesson planning.

3. Sub-Group Work: Conditions for Designing AI Courses

Operating within the first driver, the sub-group on teacher training examined the pedagogical, institutional, and ethical conditions under which AI courses can effectively empower educators. Its work was motivated by three structural deficits identified in the literature (Fig.1): knowledge asymmetry, whereby teachers and students frequently lack awareness of ethical and open-source alternatives to dominant commercial platforms; pedagogical misalignment, whereby AI is grafted onto existing curricula without contextual adaptation; and a governance vacuum that exposes schools to vendor lock-in and data exploitation [1][2].

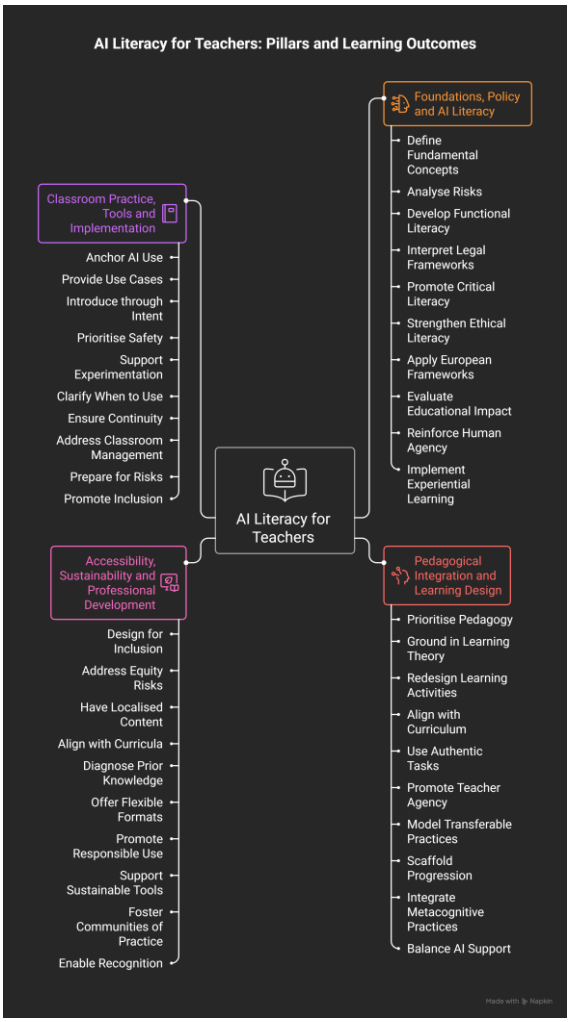


Fig.1. AI Literacy for Teachers: Pillars and Learning Outcomes

3.1 Student Competency Objectives

Responsible AI courses must develop competencies enabling critical, informed interaction with AI systems: digital literacy, computational thinking, ethical awareness, and practical application. At present, the predominance of self-directed learning as the de facto mode of AI skills acquisition produces structurally incoherent learning pathways that may inadvertently reinforce misconceptions [1]. The framework insists that structured curricular provision is not a supplementary option but a governance imperative.

3.2 Teacher Agency and Professional Risks

AI integration reshapes the professional role of teachers in ways that are simultaneously enabling and threatening [7]. Three risks require institutional attention: deskilling, whereby progressive automation of pedagogical tasks erodes professional expertise; loss of agency, whereby teachers risk being reduced to executors of algorithmically generated content; and psychological resistance arising from anxiety about professional identity dissolution [8][9]. These risks are not hypothetical; they are documented in empirical research across national contexts.
The framework's response is threefold: teacher-centred design of AI courses and tools; targeted deployment limited to clearly identified pedagogical challenges; and institutional provision of psychological support to facilitate a productive and sustainable relationship between educators and AI systems.

4. Structural Tensions in AI Adoption

Three structural tensions characterise AI adoption in European education. They are constitutive features of a genuinely complex sociotechnical transition, and the framework articulates principled responses to each.

4.1 Efficiency Versus Pedagogical Autonomy

AI systems are engineered for computational efficiency, optimisation, and scalability; education is fundamentally a relational, contextual, and intrinsically human enterprise [1]. Unmediated, this incommensurability produces a drift towards automation that progressively displaces pedagogical judgement. The framework's response is the principle of augmentation over automation: AI tools must extend what teachers can do rather than perform what teachers should do [10]. This is a categorical normative constraint, not a preference.

4.2 Ethical Compliance Versus Functional Performance

Ethically certified, European-hosted tools offer superior data sovereignty and GDPR compliance but may underperform commercially dominant tools operating outside European regulatory frameworks [2]. Rather than treating this as a binary choice, the framework advocates a stratified strategy: certified tools as the default institutional choice; structured negotiation with commercial providers for contractual safeguards on data use and pedagogical autonomy; and clearly delimited use of commercial tools with explicit constraints on data access and automated decision-making.

4.3 Standardisation Versus Curricular Diversity

The fragmentation of European educational systems — across languages, national curricula, pedagogical traditions, and regulatory frameworks — renders rigid standardisation both practically impractical and normatively undesirable [1]. The framework's response is the concept of flexible standardisation: common frameworks provide structural coherence while systematic local adaptation, peer learning communities, and multi-directional knowledge exchange preserve institutional autonomy and contextual relevance.

5. Recommendations

At the policy level, governments and European institutions should substantially increase investment in AI-specific teacher professional development programmes, introduce legally binding standards for public-private partnerships in education technology, and prioritise public funding for European AI tools designed specifically for educational contexts.
At the institutional level, educational establishments should adopt ethical procurement frameworks for AI tools, involve teachers actively in tool selection and evaluation, and establish communities of practice for sharing AI course design experiences across disciplines and national contexts.
At the level of individual educators, a stance of informed criticality towards AI tools, active engagement in co-design processes, and an incremental implementation strategy allowing for evidence-based adjustment of practice over time are the conditions under which responsible adoption can be sustained [2].

6. Discussion and Limitations

As an EDEH working document, the Main Drivers Framework has not been subject to formal peer review or large-scale empirical validation, and several recommendations retain a prospective and normative character. Its European scope may limit applicability to contexts operating under different regulatory regimes and institutional traditions. The pace of AI development also means that specific tool recommendations risk rapid obsolescence — a vulnerability the framework mitigates by anchoring guidance in durable pedagogical principles rather than in the capabilities of particular tools.
AI adoption in European education carries genuine risks alongside real opportunities. The risks — loss of professional autonomy, overreliance on AI, data exploitation, reinforced inequities, commercialisation of education, linguistic and cultural hegemony, spread of misinformation and bias, and environmental impact [11] — fall disproportionately on educators in less well-resourced systems. A framework that insists on teacher agency as both the means and the end of responsible AI adoption is therefore also, implicitly, a framework for educational equity.

7. Conclusion

Responsible AI adoption in European education requires more than technical guidance: it requires a governance architecture that places pedagogical agency, ethical grounding, and systemic sustainability at its centre. The EDEH AI Squad's Main Drivers Framework offers such an architecture — modular, human-centred, and attentive to the structural tensions that any serious engagement with AI in education must navigate. The four drivers — teacher training, co-design, public-private partnerships, and data literacy — are designed to function as a coherent yet flexible toolkit, not a prescriptive hierarchy.
Future research should prioritise empirical validation across diverse European educational contexts, and the development of evaluation instruments capable of measuring the impact of human-centred AI adoption on both learning outcomes and teacher professional wellbeing.

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Digital Transformation and Student Engagement in Higher Education: An ICT and E-Learning Perspective

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Abstract

The digital transformation of higher education has reshaped pedagogical practice and the conditions under which students engage with academic content. Despite substantial institutional investment in Information and Communication Technologies (ICT) and e-learning platforms, the literature has yet to produce a coherent account of how such investment translates into meaningful student engagement. This paper synthesises peer-reviewed scholarship on digital transformation, ICT adoption and e-learning quality to develop an integrated conceptual framework grounded in the Technology Acceptance Model (TAM), Constructivist Learning Theory (CLT) and the Student Engagement Framework (SEF). Drawing on a narrative and critical review of literature published between 2013 and 2026, the analysis examines how perceived usefulness, instructional design and institutional support converge to shape the behavioural, cognitive and emotional dimensions of engagement. The synthesis demonstrates that digital transformation enhances engagement only when ICT tools are accessible, pedagogically aligned and supported by digital readiness, leadership and inclusive design. Conversely, infrastructural deficits, weak instructional design, low digital literacy and persistent digital divides constrain engagement, particularly in South African and developing-country contexts. The framework positions student engagement as the central outcome of an enabled, mediated and pedagogically grounded transformation process. It offers theoretical, practical and policy guidance for advancing engagement-centred digital strategies in resource-constrained higher education settings.

Keywords: *Digital transformation; student engagement; ICT in education; e-learning quality; technology acceptance; South African higher education*

1. Introduction

Over the past decade, the integration of digital technologies into higher education has accelerated, repositioning ICT and e-learning platforms from peripheral instructional aids to central pillars of teaching, research and student services [1, 2, 3]. The COVID-19 pandemic acted as a forced accelerant of this trajectory, exposing both the latent capabilities and the structural fragilities of institutional digital infrastructures [4, 5]. Despite considerable investment, however, the relationship between digital transformation and student engagement remains insufficiently understood [6, 7]. Engagement, conceptualised across behavioural, cognitive and emotional dimensions, is widely regarded as a primary determinant of academic success [8, 9]. However, much of the existing scholarship examines transformation and engagement in isolation, focusing on specific tools or modalities without producing an integrated theoretical account [10, 11]. These limitations are amplified in the South African and broader developing-country context, where transformation imperatives intersect with persistent digital inequality, infrastructural constraints and the Fourth Industrial Revolution agenda [12, 13].

The existing literature exhibits three interrelated weaknesses. First, it remains fragmented: perceived usefulness, system quality, digital readiness and instructional design are typically examined in isolation rather than as a coherent multi-level account of how transformation reaches students [6]. Second, the behavioural, cognitive and emotional dimensions of engagement are seldom addressed simultaneously, with observable participation privileged in empirical work while deeper cognitive investment and emotional connection remain under-theorised [9, 17]. Third, much scholarship rests on infrastructural and cultural assumptions that do not transfer cleanly to South African and developing-country settings, where digital divides and infrastructural gaps remain constitutive of the transformation process [12, 18].

Against this backdrop, this study synthesises secondary literature to develop an integrated conceptual framework grounded in TAM, CLT and SEF, designed both to clarify how digital transformation shapes engagement and to extend the theoretical repertoire for analysing transformation in resource-constrained settings. Three objectives guide the analysis: to synthesise published scholarship on digital transformation, ICT adoption, and e-learning quality in higher education; to examine how ICT tools and

e-learning quality shape the behavioural, cognitive, and emotional dimensions of student engagement; and to integrate TAM, CLT, and SEF into a unified conceptual model. The remainder of the paper presents the literature review (Section 2), the research methodology (Section 3), the findings (Section 4), the proposed conceptual framework (Section 5), the discussion (Section 6), the study's contribution (Section 7), and the conclusion (Section 8).

2. Review of Related Literature

The literature review is organised thematically to support the conceptual framework presented in Section 5. Three thematic clusters are examined: digital transformation in higher education, ICT adoption and e-learning quality, and the dimensions of student engagement, each interrogated for the patterns on which the literature converges, the contradictions it sustains and the gaps it leaves unresolved. A concluding subsection integrates the three theoretical resources whose convergence yields the framework.

2.1 Digital Transformation in Higher Education

Recent scholarship reframes digital transformation away from tool deployment and towards a comprehensive reconfiguration of teaching, learning, research, and administrative practice [6, 19]. [14] argues that present concerns centre on organisational change, leadership, faculty experience, and inclusive strategy rather than on technology procurement alone, with digital leadership recurring as a particularly consequential capability that mediates resource allocation, faculty support, and digital culture [20, 22]. The literature remains divided, however, on the experiential consequences of transformation. One stream emphasises its productive and emancipatory potential [3, 4]; another foregrounds its costs, administrative burden, digital fatigue, faculty resistance and inequities in competence and access [23, 24]. The contradiction is one of emphasis rather than fact: the same processes generate both effects, with the relative weighting determined by the institutional substrate in which they unfold. A persistent gap persists: frameworks developed in well-resourced settings transfer poorly to South African and other developing-country contexts unless they explicitly address structural deficits in connectivity, devices, and digital literacy [13, 18]. This body of work motivates Tier 1 of the proposed framework, in which institutional digital transformation is captured as a strategic, infrastructural and cultural reconfiguration.

2.2 ICT Adoption and E-Learning Quality

If institutional transformation establishes the strategic backdrop, ICT adoption and e-learning quality constitute the technical-pedagogical mechanism through which transformation reaches students. A consistent pattern in the adoption literature identifies perceived usefulness, perceived ease of use, institutional support, infrastructural reliability and content quality as core determinants [26]. E-learning quality, operationalised through usability, content relevance, interactivity, and technical reliability, has likewise been identified as a critical determinant of satisfaction and learning outcomes [16, 27, 28], with the pattern holding across institutional types, national settings, and the most recent generation of adaptive, AI-driven, and immersive systems [29]. The literature presents a sharp contradiction, however, over whether technical quality is, in itself, sufficient. Tool-specific findings frequently fail to generalise, and a substantial body of evidence demonstrates that ICT-mediated pedagogy produces engagement gains only when integrated with disciplined teaching practice [32]. Chaturvedi et al. [34] show that effective deployment, rather than infrastructure alone, distinguishes outcomes, a finding at odds with tool-deployment narratives that treat platform quality as the dominant variable. The conceptual bridge between adoption decisions and learning engagement remains thinly developed: TAM-style accounts explain user perceptions but not how adoption translates into pedagogical conditions [35], while constructivist accounts specify those conditions but offer little guidance on adoption antecedents. This literature motivates Tier 2 of the framework, perceived usefulness, ease of use, usability, interactivity and content quality, and justifies the claim that Tier 2 is necessary but not sufficient and must be coupled with Tier 3 mediating factors.

2.3 Student Engagement Dimensions

The tripartite conceptualisation of engagement, behavioural, cognitive and emotional, has achieved near-universal adoption in the digital learning literature [8, 37]. Behavioural engagement encompasses

participation, task completion and observable interaction; cognitive engagement refers to depth of intellectual investment, metacognitive strategy use and active knowledge construction; emotional engagement captures motivation, interest and a sense of belonging. The construct's analytic robustness is substantiated by Bond et al.'s [8] systematic mapping of 243 studies. The literature, however, sustains a sharp contradiction over the relationship among the three dimensions. One stream treats engagement as additive, assuming that interventions targeting any single dimension contribute to overall engagement [38, 39]. A second demonstrates that the dimensions are configurational rather than additive: tools driving behavioural participation may simultaneously displace the cognitive depth they were intended to enable [15], and behavioural metrics frequently fail to predict learning achievement, which depends on the configurational pattern of cognitive and emotional engagement [40]. [8] further show that behavioural engagement is the most frequently observed dimension and cognitive engagement the least often theorised, skewing the empirical base toward easily measured rather than consequential variables. Recent work maps differential responsiveness: emotional engagement is tied to inclusive design, social presence and culturally responsive pedagogy [43]; cognitive engagement is most sensitive to instructional design and constructivist alignment [37]; and behavioural engagement responds most directly to access and ease of use [42]. This literature motivates Tier 4 of the framework.

2.4 Theoretical Integration

Three theoretical resources jointly yield the framework. TAM, refined in recent applications to augmented reality and emotion-augmented engagement, explains the perceptual antecedents of adoption at Tier 2 [35, 36]. Constructivist Learning Theory, applied by [44] through socio-constructivist and ecological lenses, specifies the pedagogical conditions under which adoption deepens into cognitive engagement at Tier 4. The Student Engagement Framework provides the analytic taxonomy through which Tier 4 outcomes are observed [9]. TAM accounts for perception-level antecedents, CLT for pedagogical conditions and SEF for outcome taxonomy; the mediating layer at Tier 3 is where these resources jointly do their explanatory work.

3. Research Methodology

This study employs a conceptual research design grounded in a narrative and critical review of secondary literature. The design is appropriate to the study's objective of developing a framework rather than testing a priori model against new empirical data. The narrative–critical review tradition is well established in higher education research as a vehicle for theoretical integration across heterogeneous empirical contexts. No primary data were collected, and no human participants were involved. Sources comprised peer-reviewed journal articles, edited book chapters and conference proceedings published between 2013 and 2026, retrieved from five databases: Scopus, Web of Science, EBSCOhost, ScienceDirect and Google Scholar. The 2013–2026 window captures contemporary digital transformation literature, including pre- and post-pandemic discourse on online and blended learning. Search terms combined three conceptual clusters digital transformation ('digital transformation higher education', 'digitalisation higher education', 'ICT in higher education'); adoption and quality ('technology acceptance model higher education', 'e-learning system quality'); and engagement ('student engagement digital learning', 'behavioural cognitive emotional engagement') with contextual terms such as 'South Africa', 'developing country' and 'digital divide higher education' to surface scholarship relevant to the study's regional focus. Inclusion criteria specified English-language peer-reviewed sources within the date range with a substantive focus on digital transformation, ICT adoption, e-learning quality, student engagement or technology acceptance in higher education; sources were retained where they addressed one of the three theoretical lenses or contributed empirical evidence on enabling and constraining factors. Editorials, blog posts, non-peer-reviewed grey literature, sources focused exclusively on school-level or corporate training contexts and duplicate records were excluded. The final corpus comprised 48 sources.

Analysis proceeded in three stages. The first was thematic coding: each source was coded against the three thematic clusters, and recurring patterns, theoretical claims and contradictions were identified [7, 14]. The second was theoretical mapping: each thematic cluster was related to TAM, CLT, and SEF to identify which lens did the explanatory work at each point. Convergences and divergences were used to specify the conditions under which competing claims hold, rather than to reconcile them artificially. The third was framework construction: the theoretical mapping was integrated with structural patterns from the thematic coding to produce a multi-tier framework. The framework was validated through three internal checks consistency with each theoretical lens, capacity to accommodate empirical patterns and

contradictions, and applicability to South African and developing-country contexts. Three design limitations should be acknowledged: the framework is constructed from secondary literature rather than tested against primary data; the English-language inclusion criterion may have excluded relevant Francophone and Lusophone African scholarship; and the privileging of peer-reviewed sources may underrepresent practitioner knowledge.

4. Findings

The secondary data synthesis identified four interrelated themes between digital transformation and student engagement.

Theme 1: Digital transformation is multi-dimensional, and its experiential consequences are contested

Across the corpus, digital transformation is consistently reframed as a comprehensive reconfiguration of teaching, learning, research and administrative practice rather than a tool-deployment exercise [1, 6, 19]. The literature, however, is divided over the experiential consequences of that reconfiguration. One stream documents its productive and emancipatory potential [3, 4]; another documents its costs, administrative burden, digital fatigue, faculty resistance and inequities in competence and access [23, 24]. The two streams are not factually inconsistent: the same processes generate productive and costly effects simultaneously, with the institutional substrate (strategy, leadership, infrastructure and culture) determining which effect dominates in a given setting. Two propositions follow. First, accounts presenting transformation as uniformly progressive overstate the evidence. Second, the institutional and cultural conditions under which transformation is implemented are themselves part of the explanation for engagement outcomes, not preconditions to be assumed.

Theme 2: ICT adoption and e-learning quality are necessary but not sufficient for engagement

The adoption literature consistently identifies a core set of determinants shaping ICT uptake and e-learning quality: perceived usefulness, perceived ease of use, institutional support, infrastructural reliability, content quality, usability and interactivity [4, 25–28, 32]. The pattern holds across institutional types, national settings and the most recent generation of adaptive, AI-driven and immersive systems [29–31]. The same literature equally consistently demonstrates that the presence of these determinants is necessary but not sufficient. [34] show that effective pedagogical deployment, rather than infrastructure alone, distinguishes outcomes; [33] shows interactive tools yield stronger results when they enable active rather than passive engagement; [26] shows ICT-mediated pedagogy produces engagement gains only when integrated with disciplined teaching practice. Technical and adoption-level conditions establish the possibility of engagement but do not produce it; translation depends on the pedagogical and institutional mediating layer linking Tier 2 to Tier 4.

Theme 3: Student engagement is configurational rather than additive across its three dimensions

The tripartite conceptualisation of engagement [8, 9, 37] is near-universally adopted, but the relationships among the three dimensions are contested. One stream treats engagement as additive, assuming interventions targeting any single dimension contribute to overall engagement [38, 39]. A second stream demonstrates that the dimensions are configurational rather than additive: tools driving behavioural participation may displace the cognitive depth they were intended to enable [15, 17], and behavioural metrics frequently fail to predict learning achievement, which depends on the configurational pattern of cognitive and emotional engagement [40]. [8] show that behavioural engagement is the most frequently observed dimension and cognitive engagement the least theorised, skewing the empirical base toward easily measured rather than consequential variables. Differential responsiveness is therefore both empirically warranted and analytically necessary: behavioural engagement responds most directly to access and ease of use; cognitive engagement is most sensitive to instructional design and constructivist alignment; emotional engagement is most responsive to inclusive design, social presence and culturally responsive pedagogy [37, 41, 42, 43].

Theme 4: Constraining factors are systematically more salient in South African and developing-country contexts

The mediating layer of enablers and constraints behaves asymmetrically across contexts. In well-resourced settings, enabling factors such as digital readiness, instructional design quality, institutional support, digital leadership, faculty digital competence and inclusive design dominate analytical attention [20, 22, 44]. In South African and developing-country settings, constraining factors, such as digital divides, infrastructural deficits, low digital literacy, faculty resistance, weak strategic alignment and gendered patterns of access, are systematically more salient and persistently shape engagement outcomes [12, 13, 18, 46]. Enablers are not absent in such settings; rather, the gradient of constraint is steeper, and frameworks developed in well-resourced contexts cannot be transposed unmodified without distorting empirical reality. This asymmetry is the empirical basis for the framework's decision to treat constraining factors as constitutive of Tier 3 rather than as residual noise.

5. The Proposed Conceptual Framework

Drawing on the four findings, this section presents the integrated conceptual framework, the study's principal output. The framework positions student engagement as the central outcome of a multi-level, theoretically integrated digital transformation process comprising four interrelated tiers: institutional digital transformation as the strategic driver (Tier 1); ICT adoption and e-learning quality as the technical-pedagogical mechanism (Tier 2); mediating, enabling and constraining factors (Tier 3); and student engagement in its behavioural, cognitive and emotional forms as the principal outcome (Tier 4).

Tier 1 captures the strategic, infrastructural, and cultural reconfiguration through which institutions pursue digitally enabled missions, invest in infrastructure, formulate a digital strategy, establish digital leadership, and embed digital culture [1, 2, 20]. Without institutional-level commitment, lower-level investments remain disconnected from a coherent architecture and fail to produce systemic change.

Tier 2 operationalises the mechanism through which transformation reaches students: ICT adoption depends on the central TAM variables of perceived usefulness, perceived ease of use and institutional support, while e-learning quality captures usability, content relevance, interactivity and pedagogical alignment with constructivist principles [28, 32, 35]. Tier 3 captures the mediating layer through which adoption translates into engagement. Enabling factors include digital readiness, instructional design quality, institutional support, digital leadership, faculty digital competence and inclusive design [22, 41, 44]; constraining factors include digital divides, infrastructural deficits, low digital literacy, faculty resistance and weak strategic alignment [14, 18, 23]. In the South African and developing-country context, constraining factors are systematically more salient and demand explicit institutional and policy response [12, 13]. Tier 4 operationalises the outcome through the tripartite framework of behavioural, cognitive and emotional engagement, with each dimension differentially activated: behavioural engagement by access, ease of use and infrastructural reliability; cognitive engagement by instructional design quality and constructivist alignment; and emotional engagement by inclusive design, social presence and culturally responsive pedagogy [8, 36]. Relationships among the tiers are recursive rather than unidirectional: strong engagement outcomes feed back into institutional commitment, while weak outcomes erode it [8, 23]. Through this recursive dynamic, transformation and engagement co-evolve over time.

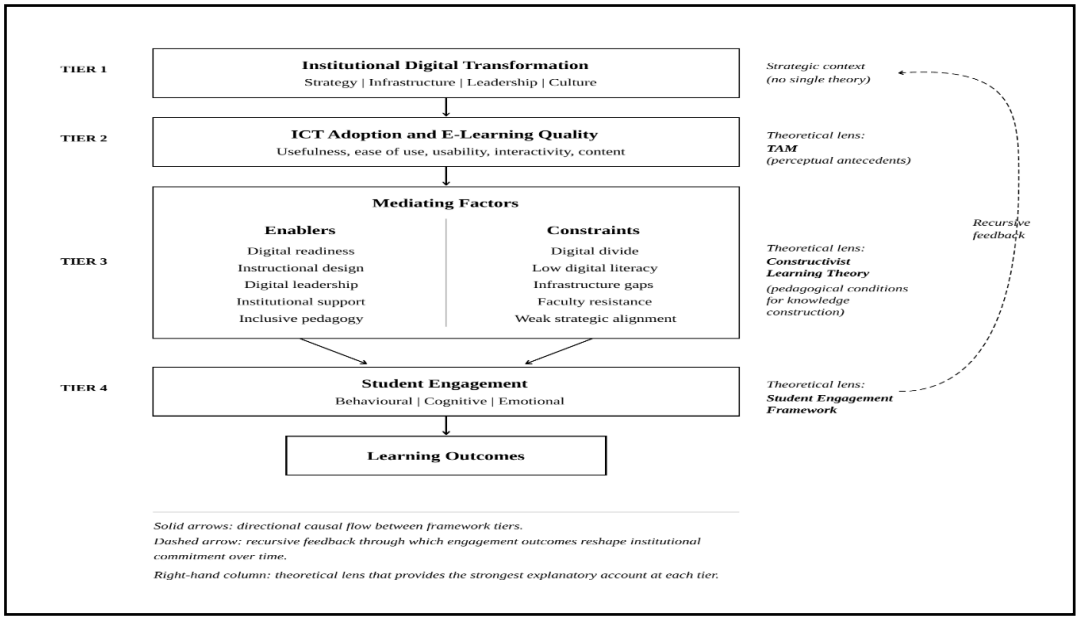


Fig. 1. illustrate the proposed conceptual framework for digital transformation and student engagement in higher education.
Source: Researcher's own Compilation

Figure 1 presents the framework as a four-tier vertical cascade together with the theoretical mapping that underwrites it. The right-hand column identifies the lens that does explanatory work at each tier: the Technology Acceptance Model accounts for the perceptual antecedents of adoption at Tier 2; Constructivist Learning Theory accounts for the pedagogical conditions at Tier 3 under which adoption deepens into knowledge construction; and the Student Engagement Framework accounts for the tripartite engagement outcomes at Tier 4. No single theory governs tier 1 but provides the strategic context within which the lower tiers operate. Three structural features warrant emphasis. The first is the partitioning of the mediating layer into enablers and constraints, which signals that institutions cannot pursue one without managing the other; in resource-constrained settings, this symmetry is particularly consequential. The second is the convergence of two arrows from the mediating layer onto Tier 4, which encodes the analytical claim that engagement is the joint product of supportive and constraining conditions rather than the linear output of supply-side investment alone. The third is the dashed recursive feedback arrow from Tier 4 to Tier 1, which converts the framework from a static taxonomy into a dynamic system: engagement outcomes do not merely register the effects of transformation but, over time, reshape the institutional commitment, leadership choices, and digital culture that drive subsequent transformation cycles. The figure thereby visualises the central theoretical contribution of the study: the consolidation of three previously parallel literatures into a single, integrated, multi-level account of how digital transformation produces, or fails to produce, student engagement in higher education.

6. Discussion

The four findings and the framework carry implications that extend beyond the analytical claims themselves. Four interpretive moves are made. First, the dominant policy logic of digital transformation globally and in South Africa treats infrastructure investment and platform adoption as the principal levers for lifting engagement [2, 14]. Finding 2 directly contests this logic: technical conditions establish possibility but not outcome. Recent work [15] argues that supporting engagement in technology-enhanced learning requires attending to pedagogical, relational and institutional conditions. The framework's mediating layer is the analytical correction. Institutional and policy interventions that bypass Tier 3 instructional design, digital readiness, faculty competence and inclusive design should be expected to underperform regardless of the scale of Tier 1 and Tier 2 investments. Second, the configurational character of engagement has implications for institutional evaluation practice. If the three engagement dimensions are differentially activated and may move in opposition, the prevailing reliance on behavioural metrics, such as login frequency, time on platform, post counts, and completion rates, produces an evaluation system biased toward the most easily measured but least consequential

dimension. [17] and [40] provide direct empirical support for this concern. Institutions evaluating digital transformation strategies on engagement grounds will need instruments that capture cognitive depth and emotional connection alongside observable participation, with policy-level monitoring expanded commensurately.

Third, the salience of constraining factors in South African and developing-country settings is more than additional difficulty within a shared theoretical landscape. The asymmetry calls into question the implicit universalism of much global digital transformation literature, which has been disproportionately produced in well-resourced settings [2, 44]. The framework's treatment of constraining factors as constitutive of Tier 3 rather than residual noise is therefore both an empirical accommodation and a theoretical claim: structural conditions are part of the explanation of engagement, not an external scope condition. This has direct implications for how comparative higher education research is designed and how policy borrowing across contexts is justified. Fourth, the rapidly evolving technological frontier introduces new tensions. [30] and [31] demonstrate gains in engagement from AI-integrated platforms, yet [47] caution that over-reliance on AI may diminish critical thinking and authentic engagement. Within the framework, these technologies sit at Tier 2 but alter the conditions of the Tier 3 mediating layer: adaptive platforms partially substitute for instructional design effort, intelligent tutoring for instructor presence, and immersive environments potentially reshape the constructivist conditions of knowledge construction. The framework anticipates that the evaluative challenge identified in Theme 3, the asymmetric measurement of the three engagement dimensions, will intensify rather than diminish as these technologies mature, since AI-driven systems generate behavioural signals at unprecedented volume while leaving cognitive and emotional substrates harder to access.

7. Contribution of the Study

The study's primary theoretical contribution lies in developing an integrated framework that synthesises TAM, CLT and SEF into a coherent account of the relationship between digital transformation and student engagement. The framework addresses the fragmentation of the existing literature, in which these three resources have typically been deployed in isolation, and extends prior conceptualisations by incorporating mediating factors and treating the relationship as recursive rather than unidirectional. By foregrounding the South African and developing-country context, it also responds to recent calls to move beyond global-North paradigms in higher education research [2, 44]. For institutions, curriculum developers and e-learning designers, the framework provides evidence-based guidance for structuring digital learning environments that genuinely enhance engagement. It identifies the enabling conditions of digital readiness, instructional design quality, institutional support, accessible infrastructure, digital leadership and inclusive pedagogy that must be present for transformation to translate into engagement gains, alongside the constraining conditions that must be actively managed. Strategically, transformation should be planned as a coordinated programme integrating infrastructure, pedagogy, leadership development and inclusion; evaluatively, institutions should monitor engagement across all three dimensions rather than relying solely on participation metrics. For policymakers in the South African higher education sector, the framework supports three directions: investment in the mediating layers of digital readiness, instructional design, faculty development, digital leadership and inclusive pedagogy alongside infrastructure; embedding inclusive design as a foundational policy requirement given the structural inequalities and constitutional equity commitments that distinguish the South African context; and expanding policy-level monitoring beyond access and adoption metrics to capture engagement outcomes across the behavioural, cognitive and emotional dimensions [45].

8. Conclusion

This study has synthesised secondary literature on digital transformation, ICT adoption, and e-learning quality, and developed an integrated conceptual framework grounded in TAM, CLT, and SEF. The framework positions student engagement, in its behavioural, cognitive and emotional dimensions, as the central outcome of a multi-level transformation process mediated by enabling and constraining factors that are particularly salient in South African and developing-country contexts. Three principal conclusions follow. First, digital transformation enhances engagement only when ICT tools are accessible, pedagogically aligned and supported by institutional readiness, leadership and inclusive design. Second, the dimensions of engagement are differentially responsive to elements of the transformation process and therefore require coordinated intervention across infrastructural, pedagogical and cultural levels rather than concentration at a single point. Third, the South African context calls for strategies that simultaneously expand access, address infrastructural inequality, build

digital literacy and embed inclusion as a foundational rather than peripheral concern. Future empirical work should validate the framework in South African higher education settings, extend it to comparable developing-country contexts and examine the consequences of emerging AI-driven, immersive and adaptive technologies for engagement.

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Agent EDDIE – A Model-Agnostic AI Agent for Cross-LMS Content Migration, OER Integration and Didactic Quality Assurance

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Abstract

The integration of Artificial Intelligence in Higher Education is often limited to standalone tools, neglecting the structural complexity of Learning Management Systems (LMS). This paper introduces "Agent EDDIE" (Educational Didactic Digital Interchange Engine), a collaborative project between Mid Sweden University and Offenburg University of Applied Sciences. EDDIE is designed as an AI-agnostic agent capable of bridging the gap between LMS environments like Moodle and Canvas. Unlike provider-specific solutions, our architecture ensures strategic independence by decoupling the agent's logic from any specific Large Language Model (LLM). At the current stage of development, the agent has successfully demonstrated core functionalities: it autonomously authenticates within Moodle, validates course accessibility via unique IDs, generates a comprehensive inventory of student-visible elements, and utilizes LLM APIs to synthesize rudimentary course descriptions. However, the primary focus of this contribution is the strategic roadmap of the project. We outline the planned evolution of EDDIE through four critical milestones: first, the activity-by-activity technical transfer between Moodle and Canvas; second, the integration of automated linguistic translation; third, the integration of Open Educational Resources (OER) from external repositories to enhance existing courses, and finally, the implementation of a didactic audit tool. This tool will evaluate courses against abstract "studyability" rubrics, providing instructors with feedback based on pedagogical best practices. By presenting this work-in-progress, we aim to discuss the challenges of maintaining identical usability across systems and the importance of academic sovereignty in the age of AI.

Keywords: *AI-Ed, OER, LMS Migration, Digital Sovereignty, Moodle, Canvas*

1. Introduction

In the contemporary discussions on the challenges and opportunities of Artificial intelligence (AI) in education (AIED), the focus has often been on the importance of teacher training [1] [2], and how to address students AI cheating [3] [4]. Less has been published on the opportunities of using AI techniques to facilitate course management and assess the quality of course content. As pointed out by Zawacki-Richter et al. [5] AIED has been around for about more than 30 years, but it is still unclear how educators could make a pedagogical advantage of AI techniques on a broader scale, and how to achieve a meaningful actual impact on teaching and learning in higher education.

The integration of AI in Higher Education is often limited to standalone tools, neglecting the structural complexity of Learning Management Systems (LMS). Moreover, the concept of open educational resources (OER) has become prominent in technology enhanced learning [6]. At the same time, there have been research reporting on the need of quality assurance of both OER [7] [8], and entire courses in LMS environments [9] [10]. As argued in [11], the course quality can be further divided into factors such as course content quality, course relevance, course instructor quality, and course design quality.

To improve the quality of different existing LMS this paper suggests the design and development of Agent EDDIE (Educational Didactic Digital Interchange Engine). Agent Eddie is a model-agnostic AI agent who can assess the quality of LMS-courses according to variable definitions which is up to the user. Moreover, EDDIE should be able to suggest and implement improvements in different types of LMS.

Course review has long been a source of inspiration for producing new courses and developing and advancing existing courses. For teachers in higher education, the course reviews are sometimes conducted through peer review [13]. Faculty peer review of courses and course design can lead to improved and developed teaching practice, stronger teaching cultures, pedagogical exchange, as well as serving as additional information along with student evaluations [15], [16], [18]. Challenges include lack of time, faculty anxiety, unclear purposes, variable feedback quality, and lack of training for

reviewers [13], [15]. This course review process can be compared to the peer review process in publications, where there are similar challenges. Although peer review is seen as important, it can be biased, opaque, slow and harsh, with research calling for fairness, transparency, recognition, and training more open models in peer review [17]. The use of AI, or a hybrid solution, may offer alleviations to these challenges and provide new possibilities [14]. As in the publication process, teachers in higher education may appreciate the possibilities of AI course review as a faster, objective and transparent review than a review done by a colleague.

2. Method and Materials

This paper should be seen as the first part of a Design science research project comprising the five-folded process outlined by Johannesson and Perjons [20]. As presented and discussed in Humble and Mozelius [19], small scale studies, or parts of larger studies in academia can be carried out with selected parts of the full five-folded process. The first iteration of the initial phases described in this paper involves the three first phases of the process depicted below in Figure 1. below. Initially, the problem presented in this paper was identified and formulated by brainstorming and discussions among the authors during a staff training week. Later the problem explication, the defining of requirements and the beginning of the design phase have been conducted individually and with e-mail discussions among the authors. The focus has been on the first two phases, but also involves a first proof-of-concept of the design (prototype EDDIE V0.9, section 4).

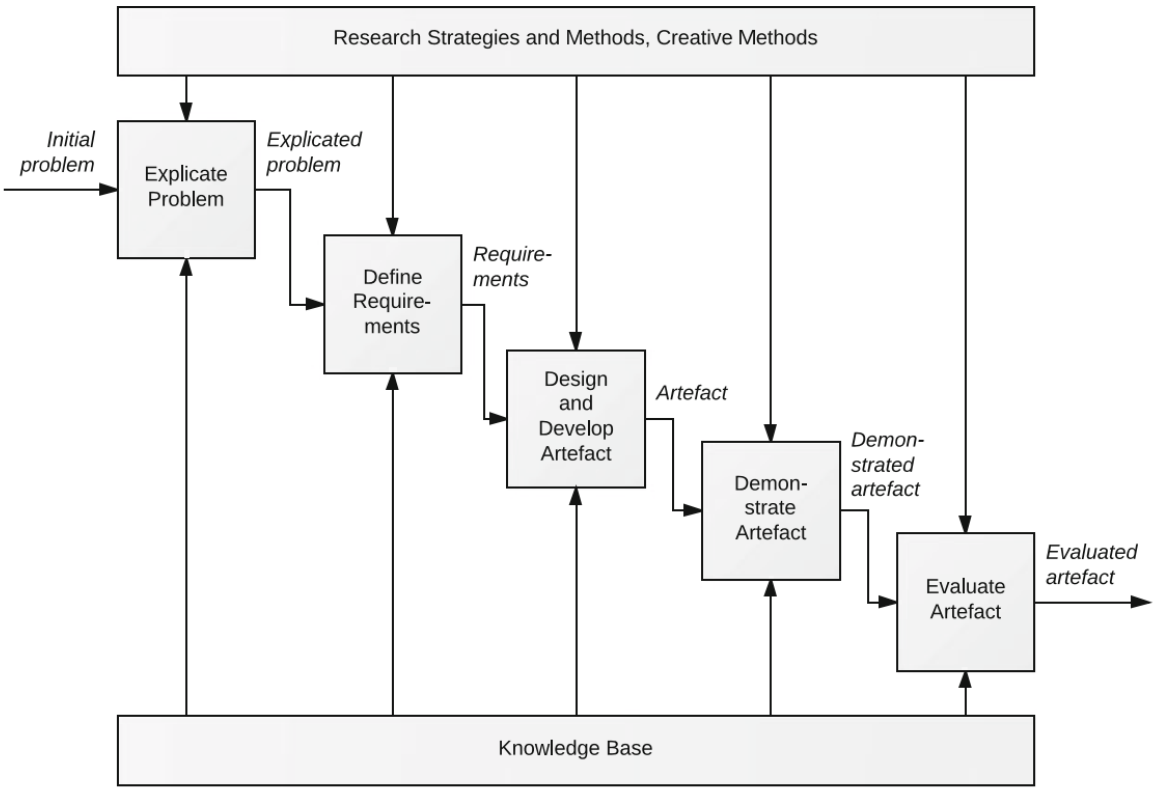


Fig. 1. The design science process as outlined by Johannesson and Perjons [12], p. 82

2.1 Current Situation of AI in Higher Education

Current research into the integration of AIED has been established for over 30 years, yet it remains primarily focused on profiling and prediction, adaptive systems, or intelligent tutoring systems [5]. While systematic reviews identify a vast array of potential applications, there is a noted lack of critical reflection on pedagogical implications and a "trust gap" regarding the delegation of course management to automated systems. The evaluation of didactical content through AI-mediated rubrics is an emerging pattern in the literature, though currently limited to sub-course granularity. Recent studies [26] have demonstrated the use of Natural Language Processing (NLP) to score classroom discussion transcripts

against instructional quality rubrics. Similarly, projects have utilized GPT-4 to compare human-crafted learning objectives against AI-generated ones based on criteria such as "SMART" alignment and course goal consistency. A systematic surveys of LLM Agents for Education [27] reports no existing project that combines course-activity-level rubrics with automated AI evaluation.

3. Concept

Faculty trust for granting access to a live LMS must be earned at the level of the agent's operating envelope, not at the level of its outputs alone. To help building trust to the concept, we have stated basic principles (P1-P5) for EDDIE:

3.1 Non-delete (P1)

EDDIE's first commitment is that no API call ever deletes, overwrites, or unpublishes existing material on the host LMS. Every action of the agent produces a new item, for example: an additional course, section, activity, or file whose existence is independent of the source course it derives from. EDDIE targets two platforms whose API surfaces and instructional models differ. On either of them, the design intent is the classical principle of least privilege of [21] applied to the agent's webservice token. On Moodle the token's scope is restricted to the `core_course_create` family and `core_files_upload`. On Canvas the equivalent OAuth scope is `manage_courses_add`. The corresponding delete and update functions against source-course resource handles are absent from the agent's token profile and therefore unreachable. The most defensive case of additive-only is no writes at all: The prototype (section 4) implements this case and grounds the principle in deployed code.

3.2 Invisible by Default (P2)

Every course that EDDIE creates begins in a non-discoverable state. On Moodle this is the `visible=0` in conjunction with `visibleold=0` flag-pair. On Canvas it is the equivalent `workflow_state="unpublished"` at course creation. The flag is set in the create call itself, not in a follow-up update. This is a deliberate choice that closes the otherwise small but real window in which the course exists in the public catalogue before being hidden, and is a residual risk addressed explicitly in the summary below. The LMS's own access-control layer enforces non-discoverability for invisible courses independently of any agent-side discipline.

3.3 Explicit Promotion (P3)

Switching the visible course pointer from a source course to its EDDIE-improved variant is a deliberate human action, never an agent action. A structured file (uploaded by the agent into the agent-produced course as an ordinary file resource) lists every change since the source: per activity, the agent records the source identifier, the agent-produced identifier, the type of semantic delta and a provenance bundle with the LLM provider identity, the system-prompt class, the timestamp, and the place where the instructor's acknowledgement signature is to be recorded. The manifest serves as the explanation surface aligned with the user-control guidelines and stands in analogy to the learning-to-defer framework of [22], where a learned classifier hands the decision to a human expert rather than committing to its own answer; in EDDIE the analogous boundary is promotion, the single decision that the agent never makes on its own. The provenance fields are modelled on the Content Credentials data model of the C2PA specification [23], with the practical intent that the per-activity audit log can be ingested by provenance-aware tooling outside EDDIE [24]. The same events are mirrored as xAPI statements [25] for analytics pipelines that already consume xAPI streams.

3.4 Reversibility (P4)

The source course is, at every moment in time, exactly the course the instructor authored. No agent-issued API call ever lands on its resource handles, and the principle of least privilege of [21] already invoked for P1 against deletions here serves a complementary role as it isolates the write surface. EDDIE's adapters allocate every agent-produced course as a separate `course_id` on either platform, and the agent never holds a write-handle on the source course. An instructor who deletes an agent-produced course therefore cannot affect the source. The host LMS's standard backup/restore workflow remains the institutional fallback, nothing about EDDIE's operation degrading it.

3.5 Open Source (P5)

The four preceding principles are technical commitments. The fifth is a deliberate boundary on those commitments: The EDDIE codebase will be published under a permissive MIT-class license whose warranty disclaimer is the legal complement of P1 - P4.
This means that institutional deployments are wrapped by the host institution's own risk acceptance and governance regime. Stating P5 here is not a defence against P1 - P4 but is the recognition that an architectural promise cannot replace an institutional contract, and that the two layers do different work.

3.6 Concept Summary

Three weaknesses survive the principles above and are stated explicitly here. First, data flows to the LLM provider as even a read-only agent forwards course content to an external service during course-description and matching steps. Our prototype Agent EDDIE V0.9 (section 4) uses an internal LLM proxy, which keeps the egress traffic inside the institutional perimeter, but data minimisation across providers remains an open work item. Second, the visibility race introduced under P2 is closed by setting the `visible=0` flag in the create API call itself, not in a follow-up update: but the soundness of this mitigation depends on the LMS's own atomicity guarantees, which neither Moodle nor Canvas documents formally. Third, the mis-promotion failure, since an instructor may click acknowledge without reading the manifest. UX guard rails as a required reading delay, a counter-signed-by line or a visualisation of the diff prior to the action are deferred to future work. In summary, defensive operation is necessary but not sufficient and is a necessary condition for an institution's consent to deploy Agent EDDIE.

4. Prototype

As a proof-of concept. a prototype of agent EDDIE with limited functionality has been build. The authors wish to thank Mohammad Dahi (HS Offenburg) for his implementation, EDDIE V0.9. It provides the most defensive instance of P1 as it has read-only access. The prototype observes a Moodle test instance, hands the observation to a controlled LLM endpoint, and renders the result as a per-module traffic-light view as a quality measure.
V0.9 is a four-step pipeline. A `core_course_get_courses` web-service call, authenticated by a single `wstoken`, returns the full course list with each entry's visible flag. The list is combined with a static module list in V0.9 hard-coded into the script, with module-handbook ingestion deferred to the first milestone (M1) discussed in Section 5. Both lists are forwarded to the HSO-internal LLM proxy (llm-proxy.imla.hs-offenburg.de, model gpt-5.1, temperature=0), which returns structured JSON mapping to each module to matched courses and their visibility status. The JSON is finally rendered as a tabular per-module traffic-light view (Fig. 2). The Moodle endpoint accessed by V0.9 is the institutional test instance, not production as the boundary between the two remains an institutional governance question.

	Modul	Kurs	Status
0	Mathematik 1	Mathe Gisela (G. Hillenbrand, Fakultät M, CeLT)	sichtbar
1	Physik Grundlagen	Physik Chatbot - RAG mit eBook-PDF (D. Giel, F...	sichtbar
2	Informatik Einführung	None	fehlt
3	Programmierung 1	None	fehlt
4	Statistik	Statistik HSOh! (Sokratischer Dialog) RAG (ext...	sichtbar
5	Statistik	Statistics HSOh! (Sokratischer Dialog) RAG-min...	sichtbar
6	Statistik	Statistik mit Python (Decker)	sichtbar
7	Software Engineering	Software-Engineering (C. Schmidt, V. Sänger, K...	sichtbar
8	Betriebspraktikum	Betriebspraktikum im WS 2022/23 + SS 2023 (AI,...	unsichtbar

Fig. 2. Sample output of EDDIE V0.9 provided by Mohammad Dahi (HS Offenburg)

EDDIE V0.9 was executed once by the implementer on 2026-04-30 against the HSO Moodle test instance. The inputs were a static list of nine study modules excerpted from a faculty handbook and the live course inventory of the test instance. Notice that there is a triple-match to "Statistik" with three corresponding courses (all with similar, but not identical titles) identified by the LLM's matching.

5. Future Work

EDDIE V0.9 is the first artifact created in order to build a fully-functioning AI agent, a proof-of-concept for the idea of using AI to automate certain (easy) tasks. We derived four milestones on the way which according to their complexity are:

5.1 Inter-System Course Transfer (M1)

At milestone M1, EDDIE is capable of transferring a basic LMS course from Moodle into Canvas and vice versa. Due to the open nature of the LMS (for example, novel plug-ins), the number of transferable items is limited and the transfer thus always partial. As pointed out earlier, EDDIE needs a rubric to evaluate course quality: The number of “transferable items” might be used (yet not improved by EDDIE) at this stage.

5.2 Inter-Language Course Transfer (M2)

At milestone M2, EDDIE can translate the language of LMS courses without altering the course items. As a quality rubric, one could pass part of the translated text to an LLM to evaluate if and how well the language matches a given particular language (for example, technical English). Then EDDIE could compare different system prompts to achieve an optimal for optimum translation quality. Translation itself could also be done using an LLM (not necessarily the same as for the quality rubrics).

5.3 OER Integration (M3)

At milestone M3, EDDIE is capable of analysing a course’s use of external learning resources (books, audio, video). As a quality metrics, it is capable of determining the appropriate abundance of external resources and estimate their respective license information. If material without or with unclear licence status is found, EDDIE offers to add an appropriate OER replacement or license. If OER material with insufficient license information is found, EDDIE offers to add the necessary information.

5.4 Didactic Quality (M4)

At the final milestone M4, EDDIE is capable of evaluating how good courses for a desired outcome, prior knowledge and student work-load look like. EDDIE can conduct an automated activity-level audit on courses running on a live LMS, suggest measures to improve didactic quality [9] and implement them (in hidden courses, according to P2 and P3).

6. Conclusion

Agent EDDIE represents a significant step toward achieving academic sovereignty in the integration of AI within Higher Education. By decoupling the logic of course auditing and migration from specific LLM providers, the project ensures that universities maintain control over their pedagogical data and instructional standards. The current V0.9 prototype successfully demonstrates the feasibility of automated course auditing via a model-agnostic proxy layer. Future milestones are inter-system migration and automated OER integration. EDDIE will provide educators with the tools to bridge the "trust gap" and ensure that digital learning environments remain both high-quality and pedagogically sound in an increasingly automated landscape.

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Artificial Intelligence for Teaching Reading: A Bibliometric Analysis of Research Trends, Collaboration, and Scholarly Development

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Abstract

Artificial Intelligence (AI) has emerged as a transformative educational technology with potential to improve reading instruction through personalised learning, adaptive feedback, accessibility, and learner-centred pedagogical support. Despite increasing scholarly interest, research on AI for teaching reading remains fragmented across educational and technological domains. Therefore, this study aims to conduct a bibliometric analysis of scholarly publications on the use of Artificial Intelligence for teaching reading to map the intellectual structure, publication trends, collaboration patterns, and thematic development of the field. A total of 10,587 English language scholarly publications were analysed using bibliometric techniques, including keyword co-occurrence, co-authorship, and country-level scientific production visualised through VOSviewer. Findings indicate growing scholarly attention toward adaptive learning, intelligent tutoring systems, multilingual literacy support, learner engagement, accessibility, and AI literacy. However, challenges relating to digital inequality, infrastructure readiness, ethical governance, and teacher preparedness remain evident. The study provides evidence-based insights to inform future research, educational policy, and pedagogical practice concerning responsible and inclusive AI-supported reading education.

Keywords: *Artificial Intelligence; Teaching, Reading, AI literacy, Pedagogical support*

1. Introduction

Reading is a foundational skill that underpins academic success [1]. While the study [2] highlights that it strengthens critical thinking as a predictor of reading, and lifelong learning. Further, the work of the study of [3] sees it as a gateway to knowledge acquisition across all disciplines. In contemporary education systems, the ability to read for meaning is essential for learner progression and overall educational attainment. However, global and local evidence suggests that many learners continue to struggle with reading proficiency, limiting their academic and socio-economic opportunities. Multiple studies highlighted that a significant proportion of learners are unable to read for meaning at grade-appropriate levels [4-7]. According to [8], highlights a persistent literacy crisis that affects both school and tertiary education outcomes. These challenges are often exacerbated by socio-economic inequalities, limited access to reading materials, and language barriers in multilingual contexts. At the same time, rapid advancements in Artificial Intelligence (AI) are transforming the educational landscape [9], by enabling more personalised, adaptive, and data-driven learning environments.

AI technologies, including natural language processing, machine learning, and intelligent tutoring systems, have increasingly been integrated into digital reading platforms to support learners' comprehension and engagement. Digital reading itself has evolved significantly, characterised by interactive, multimodal, and non-linear text engagement, which offers new opportunities for enhancing learning but also introduces challenges such as reduced deep reading and increased scanning behaviours. AI has the potential to mitigate these limitations by guiding learners through personalised reading pathways, providing real-time feedback, and adapting content to individual learning needs.

Despite significant advancements in Artificial Intelligence (AI)-enabled educational technologies, the integration of AI in teaching reading remains uneven, fragmented, and contextually dependent. Existing scholarship demonstrates that AI technologies possess considerable potential to improve reading comprehension, vocabulary acquisition, learner engagement, and personalised instructional support through adaptive learning systems, intelligent tutoring systems, AI-based chatbots, and generative technologies that tailor learning to individual learner needs [10 -12]. Studies increasingly show that AI-supported reading systems can strengthen literacy development by improving learner interaction with reading materials, enabling personalised differentiation, and supporting adaptive feedback processes

[12,13]. For example, research examining AI-mediated reading environments demonstrates positive associations between AI-supported pedagogical interventions and learner reading achievement, motivation, self-efficacy, and critical thinking [12]. However, much of the literature remains concentrated on specific technological applications, isolated educational contexts, or discipline-specific settings, thereby limiting broader understanding of scalable and sustainable AI implementation in literacy education across diverse educational systems [14,15].

Moreover, several structural and institutional barriers continue to constrain the effective implementation of AI within reading education. Persistent challenges associated with digital inequality, inadequate technological infrastructure, insufficient educator preparedness, and concerns relating to ethical governance and learner privacy continue to influence educational adoption and implementation outcomes ([14,15]. Studies further highlight concerns relating to uneven access to educational technologies, implementation costs, mismatched institutional readiness, and inadequate teacher competencies needed to support AI integration effectively within teaching and learning environments [16,17]. These constraints may be particularly pronounced in multilingual, under-resourced, and socio-economically disadvantaged educational contexts, where technological disparities risk reinforcing rather than reducing educational inequalities. Importantly, despite growing scholarly attention toward AI supported educational interventions, there remains a lack of comprehensive synthesis capable of systematically mapping the intellectual structure, thematic evolution, publication trajectories, and collaboration patterns within the field, particularly regarding key dimensions such as personalisation, accessibility, learner outcomes, and educational inclusion.

The need for such synthesis is particularly critical within the Global South, where persistent structural inequalities in educational systems demand scalable, inclusive, and contextually responsive educational interventions. AI-supported reading technologies offer important opportunities to strengthen literacy development by improving access to reading materials, enabling multilingual educational support, enhancing adaptive instruction, and supporting personalised literacy pathways for diverse learner populations [10–11,18]. Emerging scholarship further demonstrates that AI-mediated reading interventions may contribute to more inclusive educational environments through differentiated learning support and intelligent educational scaffolding capable of responding to learner variability and contextual constraints [14,19]. However, without a systematic understanding of how scholarships in this domain have evolved, researchers, educators, and policymakers may struggle to identify dominant themes, conceptual gaps, and future research priorities capable of informing evidence-based educational interventions.

Therefore, this study aims to conduct a bibliometric analysis of Artificial Intelligence as a tool for teaching reading to map the intellectual structure of the field, analyse publication trends, and identify dominant scholarly themes concerning the current level of research, influential contributors, collaboration structures, and future research directions emerging within AI-supported reading education. Specifically, the study seeks to examine the growth trajectory of scientific output, identify influential authors and collaborative networks, and explore thematic clusters shaping scholarly development. By doing so, the study contributes toward a deeper understanding of how Artificial Intelligence is reshaping reading education and provides evidence-based insights capable of informing future research, educational policy, and pedagogical practice aimed at promoting inclusive and high-quality literacy education.

To address the identified knowledge gap and provide a systematic overview of scholarly development in the field, the study was guided by four research questions. These questions focus on publication growth, scholarly collaboration, thematic development, and emerging research directions within Artificial Intelligence supported reading education. Research Questions:

RQ1: What are the publication trends and growth trajectories of research on Artificial Intelligence for teaching reading?

RQ2: Who are the most productive authors, institutions, countries, and collaborative networks in the field?

RQ3: What thematic and conceptual structures characterise research on AI supported reading education?

RQ4: What emerging research trends and future directions shape AI-supported reading instruction?

2. Literature Review

A growing body of scholarship demonstrates that AI can enhance reading instruction by supporting personalised learning and differentiated access to text. The study of [12] argues that AI tools can assist teachers in adapting children's reading materials to different learner needs, thereby creating opportunities for personalised reading support in early childhood and elementary education. Similarly,

[20] show that AI large language models can improve readability by simplifying educational materials to more accessible reading levels while retaining accuracy and content quality. These studies suggest that AI can support reading accessibility by modifying text complexity, scaffolding learner comprehension, and enabling more inclusive access to learning materials.

AI has also been explored as a mechanism for improving reading comprehension and learner engagement. The study of [21] emphasized that using PISA reading data across 32 OECD countries, found that ICT-related learner autonomy, competence, and school-level digital resources were associated with reading performance in blended learning settings. Their findings suggest that AI-informed and data-driven approaches can help educators better understand the relationship between digital learning environments and reading outcomes. The study of [12] further demonstrates that graphical summarisation combined with AI-based chatbots can improve learners' reading comprehension achievement, motivation, self-efficacy, critical thinking, and cognitive load. This indicates that AI can strengthen reading instruction not only by providing content but also by supporting metacognitive engagement, feedback, and learner confidence.

In language education, AI-supported reading is increasingly linked to English as a Foreign Language (EFL) and multilingual learning contexts. The study of [19] conceptualises AI as a mediating tool for EFL reading innovation through the SAMR model, showing how AI can shift reading tasks from basic comprehension activities toward more inquiry-driven literacy practices. The study of [21] similarly propose a generative pre-training-based intelligent tutoring system for English teaching, highlighting the potential of AI to address uneven access to personalised tutoring and learner support. Further, [23] found that AI chatbots can support English language learning by improving classroom interaction and learner experience. These studies suggest that AI may be particularly useful in multilingual and EFL contexts where learners require differentiated linguistic support, feedback, and guided practice.

Emerging research also highlights AI's role in early literacy and foundational reading development. The study of [13] examined the use of an AI-based conversational chatbot in kindergarten reading instruction and found that AI may support decoding practice and early grapheme phoneme correspondence development. This is important because early reading competence forms the basis for later reading fluency, comprehension, and academic success. Similarly [18], argues that extensive reading can be reconceptualised in the age of AI, as intelligent systems may help provide abundant, comprehensible, and self-selected reading input while addressing practical challenges related to resources, assessment, and learner motivation.

Despite these opportunities, literature also identifies important constraints. The study of [14] highlight that although AI can improve college English instruction through personalised learning and efficiency, challenges remain regarding implementation costs, resource allocation, and teacher training. Similarly [15], identify broader challenges in AI adoption in education, including ethical concerns, institutional preparedness, and uneven readiness for implementation. In rural and under-resourced contexts, [17] show that AI-augmented and culturally responsive multimedia can support EFL reading comprehension, but such interventions require contextual sensitivity, infrastructure, and pedagogical alignment. These findings suggest that AI-supported reading education cannot be separated from issues of digital inequality, teacher readiness, ethical governance, and local educational conditions.

Overall, the literature indicates that AI has considerable potential to support teaching reading through personalisation, adaptive feedback, accessibility, multilingual support, and learner engagement. However, current scholarship remains fragmented across different tools, educational levels, language contexts, and methodological approaches. There is therefore a need for bibliometric analysis to map the intellectual structure, publication trends, collaboration patterns, and thematic evolution of research on Artificial Intelligence as a tool for teaching reading.

3. Research Methodology

3.1 Research Design

This study employed a bibliometric research design to analyse the scientific development of research on Artificial Intelligence (AI) for teaching reading. Bibliometric analysis is a quantitative approach used to examine publication patterns, collaboration networks, thematic structures, and intellectual development within a research domain. The method was selected because it enables the systematic mapping of large bodies of scholarly literature and provides objective insights into research trends and knowledge structures.

3.2 Data Source and Selection Strategy

Data was retrieved from the Scopus database because of its extensive coverage of peer-reviewed scholarly publications and citation metadata. The search was conducted in June 2026 using combinations of keywords related to Artificial Intelligence, reading, literacy, and education. The search query was applied to titles, abstracts, and keywords. An initial dataset of 23,275 records was retrieved.

3.3 Inclusion and Exclusion Criteria

Table 1 illustrates the inclusion criteria, which restricted the analysis to English language journal articles indexed in the Scopus database and focused on AI and reading.

Table 1. Inclusion and exclusion criteria

Inclusion Criteria	**Exclusion Criteria**
English language publications	Non-English publications
Articles	Conference papers, book chapters, books and other
Publications related to AI and reading education	Publications unrelated to teaching reading
Indexed in Scopus	Non-indexed sources

3.4 Bibliometric Analysis Procedure

The bibliometric analysis was conducted using VOSviewer software. The search string included terms related to artificial intelligence ("artificial intelligence" OR "AI" OR "machine learning" OR "natural language processing" OR "intelligent tutoring systems") AND ("reading" OR "reading comprehension" OR "literacy" OR "digital reading") AND ("education" OR "teaching" OR "learning" OR "instruction") Boolean operators AND OR were employed to combine concepts and maximise retrieval accuracy while maintaining relevance. Table 2 illustrates the inclusion criteria restricted the analysis to articles and scholarly documents written in English. From an initial dataset of 23,275 retrieved publications, a total of 10,587 articles and documents met the inclusion criteria and were retained for analysis.

Table 2. Documents published in Scopus

Document type	**Number of results**
Article Conference paper Book chapter Book Other	11,030 8,155 1,495 460 2135
Total	23275
Inclusion: Articles and written in English	10587

4. Results and Discussion

4.1 Publication Trends and Growth Trajectories

The results in Figure 1 demonstrate a substantial increase in scholarly production, particularly between 2021 and 2025, where publications increased from 633 to 3,304, representing a growth rate of approximately 422%. The 2026 value represents a partial year at the time of data collection.

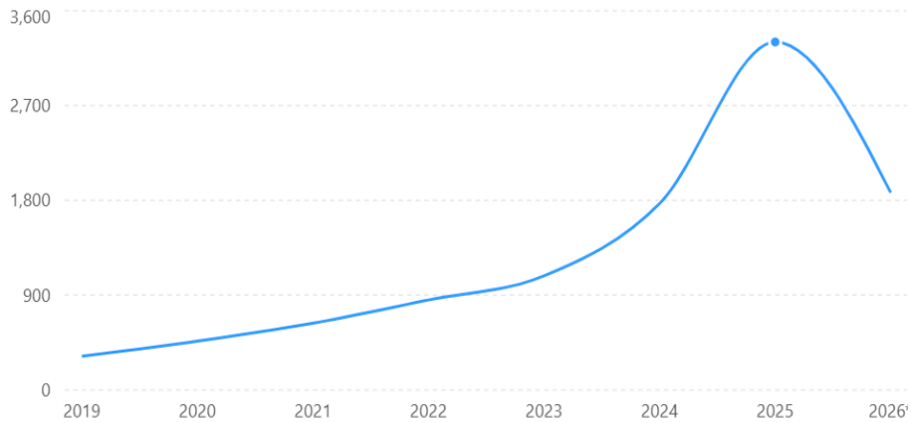


Fig. 1. Annual publication output indexed in Scopus (2019–2026).

4.2 Co-Authorship Network

The co-authorship analysis in Figure 2, identified 84 authors distributed across 12 collaboration clusters, revealing a fragmented yet moderately interconnected scholarly network. The visualisation indicates the presence of several central collaborative nodes, particularly around authors such as Wang Ying, Zhang Yu, and Zhang Wei, who appear to function as bridging scholars linking multiple research groups. While collaboration is evident, the high number of clusters relative to total items suggests dispersed research activity characterised by small institutional or thematic teams. Peripheral authors and isolated subgroups further indicate limited cross-cluster collaboration, highlighting opportunities for stronger international and interdisciplinary partnerships within the field.

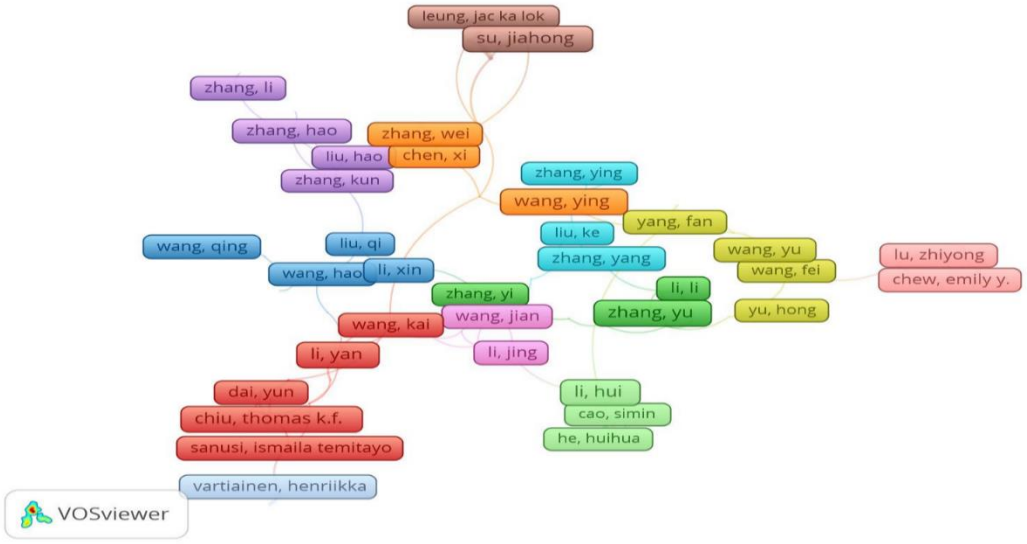


Fig. 2. Co-authorship network

4.3 Country Level Production

Country-level scientific production in Figure 3 provides important insights into geographical distribution, intellectual concentration, and internationalisation of scholarship concerning Artificial Intelligence (AI) as a tool for teaching reading. Countries with stronger technological infrastructures and advanced higher education systems appear to contribute more substantially to the development of AI-supported reading scholarship, particularly in relation to intelligent tutoring systems, adaptive learning environments, personalised literacy instruction, and generative AI applications [10,15]. These findings suggest that scientific production in this domain remains closely associated with national investments in digital education, technological innovation, and educational transformation agendas.

Importantly, the findings suggest that Global South representation remains comparatively limited, despite the significant literacy challenges affecting many developing educational systems. This imbalance is noteworthy because multilingualism, educational inequality, teacher shortages, limited instructional resources, and infrastructural constraints remain particularly pronounced across many Global South contexts [5; 8]. Consequently, there exists an important opportunity for future scholarship to strengthen representation from under-researched educational systems and to examine context-sensitive approaches to AI-supported literacy instruction in resource-constrained settings.

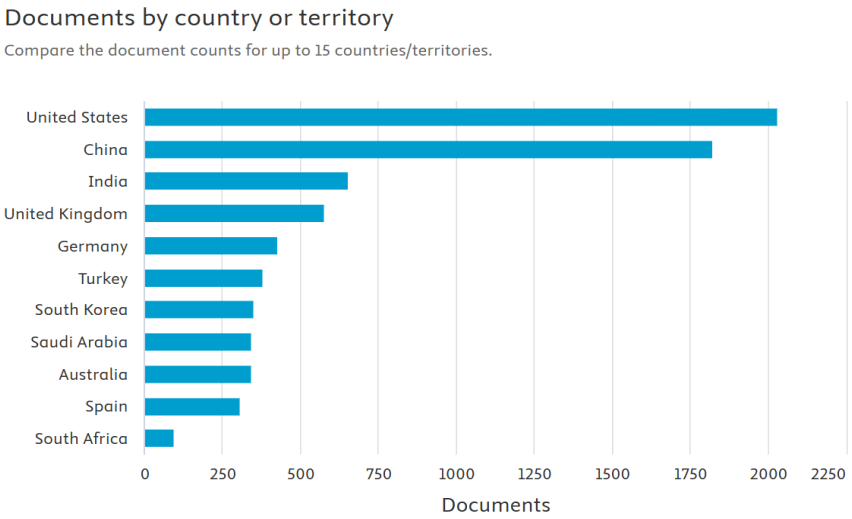


Fig. 3. Countries' level of documents

4.4 Keyword Co-Occurrence Network

Keyword co-occurrence Network in Figure 4, reveals that the intellectual evolution of artificial intelligence scholarship between 2021 and 2025. Early research focused predominantly on technical applications of machine learning, including image processing, segmentation, data mining, and intelligent tutoring systems. From 2023 onward, scholarships increasingly shifted toward interdisciplinary and human-centred applications involving information literacy, explainable AI, telemedicine, and critical thinking. More recent studies (2024–2025) demonstrate strong emphasis on AI literacy, large language models, patient education, and generative AI platforms such as ChatGPT-4o, Claude, and Google Gemini. The prominence of keywords such as artificial intelligence, machine learning, AI literacy, and large language models suggests an emerging paradigm shift toward responsible, competency-driven, and human centred AI integration across education and healthcare contexts.

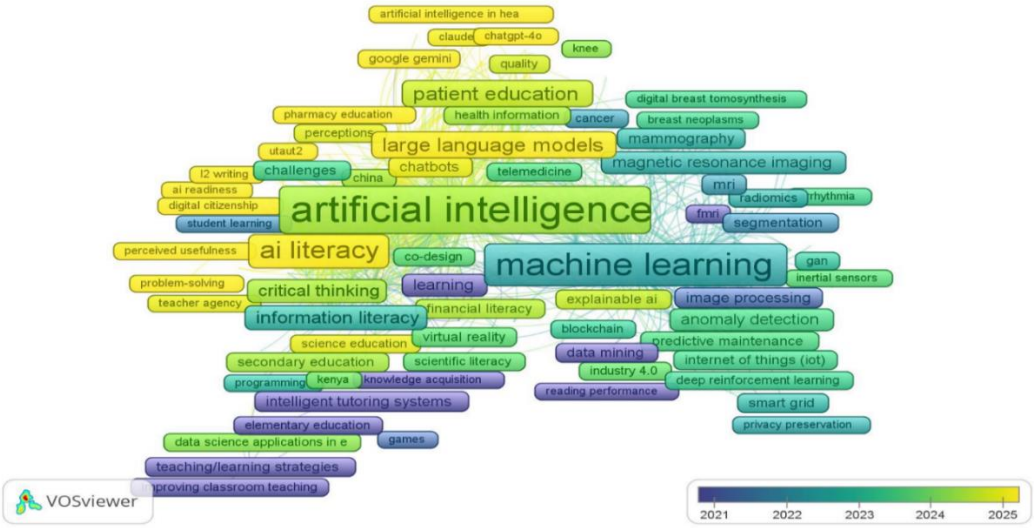


Fig. 4. Keyword Co-occurrence Network

5. Limitations

This study relied exclusively on the Scopus database as the source of scholarly publications. Although Scopus is widely recognised as one of the largest and most comprehensive citation databases, reliance on a single database may have limited the retrieval of relevant studies indexed in alternative sources such as Web of Science, ERIC, IEEE Xplore, ACM Digital Library, SpringerLink, and Google Scholar. Consequently, relevant scholarships concerning AI-supported reading instruction may not have been fully captured. Additional limitations include English-language bias, exclusion of grey literature, potential keyword-search limitations, and reliance on bibliometric techniques that may not fully capture contextual or pedagogical nuances.

6. Conclusion and Future Research Avenues

The primary objective of this study was to examine the intellectual structure and scientific development of scholarship concerning Artificial Intelligence as a tool for teaching reading through a bibliometric analysis of scholarly literature. By systematically analysing publication patterns, thematic evolution, collaboration structures, and conceptual relationships, the study sought to map current scientific development and identify future research directions shaping AI-supported literacy education.

The findings reveal that scholarships concerning AI supported reading instruction constitute an emerging yet rapidly expanding field, characterised by increasing interdisciplinary integration and growing pedagogical relevance. Publication trends demonstrate increasing scholarly attention toward adaptive learning, intelligent tutoring systems, personalised literacy support, learner engagement, accessibility, and multilingual educational technologies. At the same time, keyword co-occurrence analysis suggests a clear thematic transition from technology-oriented experimentation toward more learner centred, pedagogically meaningful, and ethically informed educational applications.

The co-authorship and country analyses further indicate that while scholarship demonstrates increasing collaboration and internationalisation, scientific production remains moderately fragmented and geographically uneven. Contributions appear concentrated within technologically advanced educational systems, while representation from Global South educational environments remains comparatively limited despite persistent literacy challenges requiring scalable educational interventions.

Importantly, the findings reinforce the growing significance of Artificial Intelligence as a pedagogical mechanism capable of supporting literacy development through personalised learning, adaptive instruction, intelligent feedback systems, multilingual educational support, and educational accessibility. However, the study simultaneously highlights persistent implementation barriers relating to digital inequality, infrastructure limitations, teacher preparedness, learner privacy, ethical governance, and responsible technological integration.

Future scholarship should therefore prioritise longitudinal learner outcomes, teacher readiness and educator competencies, Global South and multilingual educational contexts, and the pedagogical effectiveness of generative AI technologies in reading instruction. More specifically, future research should investigate how conversational AI systems, intelligent tutoring agents, adaptive literacy platforms, and large language models may be implemented responsibly while simultaneously protecting learner autonomy, promoting educational equity, and improving literacy attainment.

Future research may further benefit from mixed-method, comparative, and context-sensitive research designs capable of integrating bibliometric evidence with systematic literature reviews, classroom interventions, qualitative inquiry, and educational effectiveness studies. Such approaches may provide deeper understanding regarding the educational impact, scalability, and contextual relevance of AI-supported literacy interventions.

Overall, the study demonstrates that Artificial Intelligence scholarship in teaching reading is evolving toward a more coherent, pedagogically grounded, and socially relevant field of inquiry. Through responsible implementation, stronger interdisciplinary collaboration, and contextually informed educational innovation, Artificial Intelligence may contribute substantially toward improving literacy outcomes and advancing equitable, inclusive, and high-quality education.

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Education and Healthcare

Professional and Didactic Competence of Instructors as a Quality Criterion in Continuing Education for Emergency Medical Services and Emergency Medicine: A Trauma Care Course as an Example

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Abstract

The professional and didactic competence of instructors is considered a key quality criterion for continuing education in emergency medical services and emergency medicine, especially when it comes to complex topics such as interprofessional prehospital trauma care. The aim of the study is to examine the perceived professional and didactic competence of instructors in a trauma training course and its significance for learning relevance, interaction, and practical relevance from the participants' perspective. Two one-day training courses on prehospital trauma care for emergency medical personnel and physicians at a German educational institution in 2024 (n=21) and 2025 (n=17) were examined. The data is based on standardized evaluation forms with ratings on professional and didactic design, as well as supplementary qualitative feedback from participants. The quantitative data was evaluated descriptively, and the free comments were subjected to a structured qualitative content analysis according to Mayring [1]. Results indicate that participants predominantly rated the professional and didactic competence of the speakers as good and described the training as practical, motivating, and conducive to learning. Particular importance was attached to authentic case studies, clearly structured input, and explicitly designed interaction and reflection phases that supported interprofessional cooperation and confidence in prehospital trauma management. Criticism mainly focused on organizational aspects and communication processes. The results emphasize that professional and didactic competence is understood as a combination of professional expertise, structured learning organization, and interactive teaching. This area of competence is also perceived as a key quality feature of traumatology training courses in emergency medical services and emergency medicine. If further data analyses confirm the findings, this will have consequences for the selection and qualification of instructors as well as for the curricular design of practice-oriented, reflexive trauma training formats.

Keywords: *Interprofessional training, Prehospital trauma care, Pedagogical competence, Instructional design, Educational quality*

1. Introduction

The quality of continuing education in emergency medical services and emergency medicine is a central concern in the context of patient safety and medical professionalism [2, 3]. Prehospital trauma care in particular places considerable demands on the professionals involved: it requires not only a solid foundation of medical knowledge, but also the capacity for structured interprofessional collaboration under time pressure and in dynamic, resource-limited operational environments [3, 4, 5]. Practice-oriented, simulation-based training formats play a pivotal role in sustainably developing and consolidating these action competencies [6, 7, 8].

One aspect that has received comparatively limited empirical attention in this educational domain concerns the significance of instructors' professional and didactic competence for the perceived quality of interprofessional continuing education. While general educational research has produced extensive findings on professional instructor competencies over several decades [e.g., 9, 10], their systematic investigation in the context of continuing medical education for adults, and in emergency medicine training in particular, remains limited [11, 12].

The present study addresses this research gap. It examines how participants in an interprofessional trauma course for emergency medical personnel and physicians perceive the professional and didactic competence of the instructors, and what significance this perception holds for the learning relevance, quality of interaction, and practical orientation of the training. The empirical basis consists of

standardized evaluation forms supplemented by qualitative participant feedback collected across two course iterations at a German educational institution in 2024 and 2025. In doing so, the study contributes empirical evidence to quality development in emergency medicine continuing education and provides impetus for the curricular design as well as the selection and professional development of instructors in this field.

2. Background

2.1 Theoretical Frameworks for Professional Instructor Competence

The concept of professional instructor competence rests on a well-differentiated theoretical foundation within educational research. Of particular significance for contemporary understanding is Shulman's (1986) concept of Pedagogical Content Knowledge (PCK), which distinguishes between Content Knowledge (related to a subject), (general) Pedagogical Knowledge, and Pedagogical Content Knowledge (related to subject-specific didactic knowledge) [9]. PCK describes a specific body of knowledge which enables instructors to prepare subject matter content in a learning-conducive manner. That is, to transform complex bodies of knowledge in such a way that they become comprehensible and meaningful to the learners in question. This three-dimensional framework has since been recognized as an important reference point in international teaching and learning research [13].
In the German-speaking academic context, the model of professional instructor competence was further developed through the COACTIV research program [10, 14]. Baumert and Kunter (2011) distinguish four core competence domains: professional knowledge (comprising the sub-dimensions of subject matter knowledge, subject-specific didactic knowledge, pedagogical-psychological knowledge, organisational knowledge, and counselling knowledge), beliefs and values, motivational orientations, and self-regulatory abilities. Subject matter knowledge and subject-specific didactic knowledge are identified as the central dimensions of professional action competence, both of which have been empirically shown to be associated with instructional quality and student learning outcomes [10, 14]. Although the COACTIV competence model was originally developed as a generic framework for the school context, its underlying assumptions are transferable to contexts of vocational and continuing medical education [14].
In the domain of adult education, educational researchers emphasize that competence must always be understood as the interplay of cognitive abilities, motivational prerequisites, and practical skills, an interplay that enables situationally appropriate action [15, 16]. Professional and didactic competence in the context of continuing vocational education therefore encompasses not only the structured transmission of knowledge, but equally the design of interaction and reflection processes that are conducive to learning, as well as the capacity for adaptive learning facilitation with heterogeneous groups of participants [15, 16].
A further theoretical framework of reference is provided by the concept of Interprofessional Education (IPE) [17, 18]. The World Health Organization (WHO) defines IPE as a learning approach in which members of different health professions learn together, from and with each other, with the aim of fostering effective collaboration and improving the quality of care [19]. Instructors in interprofessional training formats must therefore possess, in addition to subject matter and subject-specific didactic knowledge, competencies in the facilitation of heterogeneous groups and in promoting interprofessional communication processes. Findings from clinical education research demonstrate that instructional quality, particularly with regard to structured knowledge transmission, clinical authenticity, and the promotion of active learning processes, contributes substantially to learning effectiveness in continuing medical education [3].

2.2 Professional and Didactic Competence in Emergency Medicine Training

The theoretical approaches outlined in this study can be applied to the specific context of trauma training in emergency medical services and emergency medicine. Prehospital trauma care is characterized by a pronounced degree of complexity and time-criticality: it requires the coordinated interaction of paramedics and emergency physicians within dynamic operational environments with limited resources [3]. Continuing education formats in this field must therefore not only convey subject-specific content, but also explicitly foster interprofessional action and communication competencies.
Applying the COACTIV-competence-model [10, 14] to the context of trauma care training, the following implications emerge for instructors: subject matter knowledge encompasses current medical and prehospital care knowledge, including clinical procedures and guideline-compliant treatment protocols.

Subject-specific didactic competence refers to the ability to prepare this knowledge in such a way that it is comprehensible and applicable in practice for participants from diverse professional backgrounds. Pedagogical-psychological knowledge, finally, is expressed in the competent design of learning sequences that are conducive to learning, sequences that integrate authentic case studies, structured content phases, and explicitly facilitated interaction and reflection phases.
In accordance with the WHO Framework for Action on Interprofessional Education and Collaborative Practice [19], appropriately qualified instructors contribute not only to the development of subject-specific competencies, but also to fostering interprofessional collaboration competency and strengthening participants' confidence in operational contexts. Against this background, the applied didactic approach, understood as the interplay of subject matter expertise, structured learning organization, and interactive instructional design, emerges as a central quality criterion of the continuing education course. Building on this theoretical foundation, the present study examines the extent to which participants in an interprofessional trauma care course perceive the professional and didactic competence of the instructors as learning-relevant, interaction-promoting, and practice-oriented, and what conclusions can be drawn from these perceptions for the curricular design and quality assurance of continuing education programs in emergency medicine.

3. Data Collection and Analysis

The empirical basis of the present study consists of standardized evaluation data from two one-day continuing education courses on prehospital trauma care conducted in Pirna, Germany. A total of N = 21 participants took part in the 2024 course and N = 17 in the 2025 course. The participants included paramedics and emergency physicians. Data was collected immediately upon completion of the respective course.
The data collection instrument was the standardized evaluation form of the Saxon Medical Association for the evaluation of externally certified continuing education events. The questionnaire captures study-relevant data including five items (Items 1.1 to 1.5), comprising both closed rating questions and dichotomous questions. Items 1.1 to 1.3 employed a five-point rating scale (ranging from excellent to very poor) to assess the perception of the overall quality of the course (1.1), the professional and didactic competence of the presenters (1.2), and the practical relevance and currentness of the course content (1.3). Items 1.4 and 1.5 used a dichotomous format (yes/no) to assess whether interaction and discussion among participants had been facilitated (1.4) and whether the scheduled time frame of the event had been adhered to (1.5). An additional open-ended text field offered participants the opportunity to provide a free-text comment.
The quantitative data from the closed-ended items were analyzed using descriptive statistics. Frequency counts were conducted for the dichotomous items. The free-text comments were evaluated through a structured qualitative content analysis following Mayring [1]. The analysis was conducted inductively: the coding process proceeded without pre-defined categories, with codes being derived directly and systematically from the data material. The aim was to represent the participants' perspectives as authentically as possible and to identify recurring patterns across responses. The study was exploratory in nature overall, with the objective of generating initial empirical findings on the perception of professional and didactic instructor competence in this emergency medicine continuing education context, thereby laying the groundwork for more in-depth future analyses.

4. Results

4.1 Quantitative Part of the Survey

Across both survey years, all five evaluated items achieved a median of 1, indicating a high level of satisfaction among most participants (Table 1). Adherence to the schedule was rated excellent unanimously by all participants in both years (M = 1.00), reflecting a consistent and reliable time structure throughout the course.
In 2024, the mean scores across all items ranged from 1.00 to 1.19, reflecting a near-uniform distribution of the highest possible rating. In 2025, the overall impression of the course showed the greatest deviation from the optimal value, with a mean of 1.41. This score nonetheless remains within the upper range of the scale. Professional and didactic competence (M 2024 = 1.19; M 2025 = 1.29) and practical relevance (M 2024 = 1.05; M 2025 = 1.12) were rated consistently positively in both years, with only marginally higher mean scores in 2025. As the medians are identical across all items and both years,

the slight differences in mean scores reflect isolated ratings in the categories good or adequate, which have no bearing on the central tendency of the distributions.

Table 1. Descriptive statistics of evaluated items 1.1 to 1.5 (N = 38)

Item	2024 (n = 21)			2025 (n = 17)		
	Mdn	*M*	*SD*	*Mdn*	*M*	*SD*
Overall impression of the course	1	1.14	.36	1	1.41	.62
Professional & didactic competence	1	1.19	.51	1	1.29	.47
Practical relevance and currentness	1	1.00	.00	1	1.18	.39
Participant interaction & discussion	1	1.05	.22	1	1.00	.00
Adherence to schedule	1	1.00	.00	1	1.00	.00

A comparison of the two survey years revealed minor differences in mean scores. In both cohorts, all mean values remained below 1.5, consistent with an overall highly positive evaluation. The overall impression did not improve from 2024 (M = 1.14) to 2025 (M = 1.41). Rather, the slightly higher mean in 2025 indicates a marginally more critical assessment, while still remaining within the range of excellent to good. Given the ordinal scale level and the small sample sizes, inferential statistical testing was not performed.

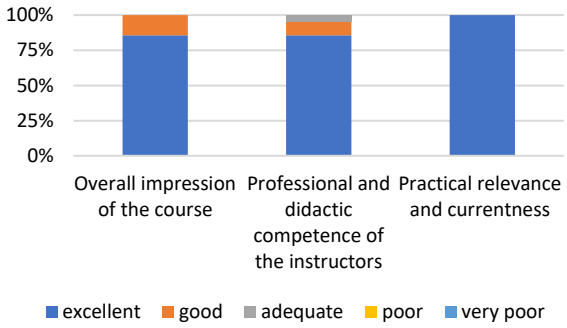


Fig. 1. Percentage distribution of participant ratings across items 1.1 to 1.3 (n = 21, 2024).

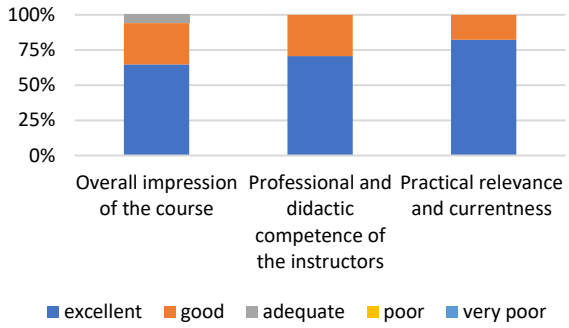


Fig. 2. Percentage distribution of participant ratings across items 1.1 to 1.3 (n = 17, 2025).

Figures 1 and 2 demonstrate the percentage frequency distribution of ratings for the three ordinally scaled items, presented separately for each survey year. In both years, the response categories “poor” and “very poor” were not selected for any of the criteria, indicating a consistently positive evaluation of the course across both cohorts.

In 2024 (n = 21), responses were strongly concentrated in the “very good” category: practical relevance and currentness were rated very good by all participants unanimously (100% each). Overall impression and professional and didactic competence were each rated very good by 85.7% of respondents. For professional and didactic competence, an additional 4.8% selected “adequate”, representing the only instance of this rating category recorded across the entire 2024 cohort.

In 2025 (n = 17), a slight shift toward the “good” category was observed across these items: professional and didactic competence was rated “very good” by 70.6% and “good” by 29.4% of participants, while practical relevance received ratings of “very good” (82.4%) and “good” (17.6%). For overall impression, 64.7% of respondents selected “very good”, 29.4% “good”, and 5.9% “adequate”.

Comparing the two survey years, a marginal increase in “good” ratings is observable for these items in 2025, while 2024 showed a stronger concentration in the highest rating category. Nevertheless, these differences must be considered negligible, as all responses in both survey years remained exclusively within the positive range of the scale.

The dichotomous items, 1.4 and 1.5, likewise received predominantly positive ratings in both survey years (Table 2). A slight improvement in perceived interaction quality is evident when comparing the two cohorts, with 2025 yielding a fully affirmative response across all participants.

Table 2. Percentage distribution of participant ratings across items 1.4 and 1.5

Year	Response	Participant interaction and discussion (%)	Adherence to schedule (%)
2024 (n=21)	Yes	95.24	100.00
	No	4.75	0.00
2025 (n=17)	Yes	100.00	100.00
	No	0.00	0.00

4.2 Qualitative Part of the Survey

Of the 38 completed evaluation forms, a total of 26 (68.4%) contained a free-text comment. Participation rates differed between the two cohorts: in 2024, 17 out of 21 participants (81.0%) provided written feedback, compared to only 9 out of 17 participants (52.9%) in 2025. Inductive categorization of the comments revealed consistent thematic priorities across both years, alongside discernible shifts in content emphasis:

1. **Time management** was the most frequently mentioned topic across both cohorts. In both years, participants repeatedly requested more time for practical exercises and skills training (*e.g., 2024: "please allow more time for the practical exercises" [Participant 2]; 2025: "would appreciate more time scheduled for practical exercises" [Participant 10]*). In the 2025 cohort, this request was articulated more specifically, including suggestions to shorten break times in favour of practice time or to allocate an additional ten minutes per station
2. **Interprofessional collaboration** was explicitly and positively highlighted by multiple participants in 2024 (*e.g., "very good collaboration" [Participant 20]; "it was great to have the physicians participate so we could practise with them" [Participant 14]*). In the 2025 cohort, this aspect was no longer mentioned in the comments, potentially indicating a normalization of the interprofessional learning format among participants
3. **Team composition** was raised exclusively in the 2025 cohort: two participants advocated for the integration of trainees into mixed teams or, alternatively, for the formation of separate trainee-only teams.
4. **Organisation and communication** were evaluated more critically in 2025 than in 2024: one participant called for improved advance communication to external participants regarding work attire, catering, and the daily schedule. In 2024, the only organisational criticism concerned the limited visibility of the event through internet searches.
5. **Overall impression and atmosphere** were commented on positively in both cohorts. Praise was directed at the quality of the case studies, the realistic nature of the practical exercises, and the pleasant learning environment. Catering received more frequent explicit positive mentions in 2024 than in 2025.

In summary, the qualitative feedback from both cohorts is thematically consistent and reflects the same central area for improvement: increased time for practical exercises. However, the 2025 comments demonstrate a higher degree of specificity and suggest a more differentiated reflection on the learning environment, particularly with regard to team composition and organizational conditions.

5. Discussion and Conclusion

The evaluation data from both survey years (N = 38) demonstrate consistently high levels of participant satisfaction: all five assessment criteria achieved median scores of 1, and the response categories “poor” and “very poor” were not selected in either cohort. The particularly high ratings for practical relevance/currentness and participant interaction/discussion indicate that the instructors successfully structured subject content in a learning-conducive manner and actively facilitated interprofessional communication processes. Both of these represent core elements of professional and didactic instructor competence as conceptualised in the COACTIV model and the WHO framework for interprofessional education [10, 14, 19]. The marginal shift in ratings toward the “good” category in 2025 should not be overinterpreted given the small sample sizes. Across both cohorts, time management represents the central qualitative theme: the repeatedly expressed desire for more time given to practical exercises points to a structural tension between the aspiration for comprehensive interprofessional competence development and the constraints of a single-day format.
For curricular development, the following recommendations are proposed: (1) extending practice time at skills development stations, (2) didactic consideration of heterogeneous participant groups, and (3)

improved advance communication for external participants. The limited sample size constrains the generalizability of these findings. A longitudinal analysis incorporating additional cohorts, supplemented by objective measures of competence, would substantially strengthen the evidence base of this study. Furthermore, the findings suggest that the selection and professional development of instructors in emergency medicine continuing education should explicitly include, alongside subject matter expertise, didactic competencies in designing interactive and practice-oriented learning sequences as well as experience in facilitating interprofessional groups as core selection criteria and qualification objectives.

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Soft Skills and Signature Pedagogies in Higher Education: A Comparative Analysis between the Humanities and Healthcare Areas

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Abstract

In contemporary higher education, soft skills are increasingly recognized as strategic competences in professional degree programs; however, their presence within curricula remains heterogeneous and often implicit. Grounded in the Dublin Descriptors and the construct of signature pedagogies (Shulman, 2005), this study investigates how soft skills are declared, integrated, and assessed in the official syllabi of four professional undergraduate programs at the University of Trieste: Education Sciences (19 syllabi), Social Work (22 syllabi), Speech Therapy (73 syllabi), and Physiotherapy (42 syllabi).
How are soft skills formally represented across different disciplinary areas? A systematic documentary analysis was conducted through recursive readings of 156 syllabi, identifying soft skills embedded in learning objectives, teaching methodologies, and assessment practices. Through an inductive analytical process, soft skills were categorized based on semantic affinities and recurrent patterns, then coded as present (1) each time the competence appeared, whether explicitly or implicitly; the final score is the sum of occurrences, capturing the overall pervasiveness of the phenomenon. Although occurrences were categorized as explicit or implicit during the reading process, both were assigned the same value in order to map the extent of the phenomenon as a whole; the distinction between forms of explication will be systematically addressed in the second phase of the research, through phenomenographic interviews with lecturers.
Findings reveal a shared core of soft skills (communication, critical thinking, teamwork, and analytic skills), alongside significant disciplinary variations. Humanities programs emphasize empathic-reflective capacities and dialogic-participatory competences and situated, practice-based pedagogies. A structural-discrepancy emerges in the curricular recognition of internships: highly formalized as core component in healthcare programs, they remain less structured in humanities programs, revealing implicit epistemological hierarchies between technical-procedural knowledge. These results inform curricular design aimed at fostering transformative teaching and learning practices in Higher Education. The analysis of the humanities area also serves as a methodological model for the ongoing investigation of the healthcare area.

Keywords: *Soft skills, Signature Pedagogies, Higher Education, Syllabus Analysis, Documentary Analysis*

1. Signature Pedagogies as a Device for Professional Training

Every profession rests on a distinctive pedagogy. Shulman [1] defines signature pedagogies as the specific ways in which a discipline teaches students to think, act and become professionals: “Signature pedagogies teach students to think, to perform and to act with integrity. They form habits of the mind, habits of the hand, and habits of the heart” (p.59). The construct operates on three levels: surface (visible teaching acts: lectures, placements, case discussions), deep (implicit epistemologies: learning to “see” a professional situation) and implicit (values tacitly transmitted: what matters and what is right in this profession). This partition makes signature pedagogies a powerful analytical tool for reading professional curricula - not only for what they declare, but for what they implicitly structure. Soft skills – communication, critical thinking, teamwork, reflexivity, empathy – are not decorative additions to technical knowledge but constitutive dimensions of professionalism as described by Eraut [2] and Goleman [3]: embodied modes of professional being and acting oriented by values, relationships and ethical judgements. In professional Higher Education this integration often remains implicit, fragmented and entrusted to individual teacher initiative rather than shared curricular design, despite the growing emphasis on transformative university education [6]. It is within this tension that the present research is situated.

2. Research and Methodology

The research is articulated in two phases. The first involved a systematic documentary analysis of the syllabus of undergraduate degree programs in the humanities area - Education Sciences (L-19, according to the Italian Ministry of University and Research classification, n= 19 syllabi) and Social Work (L-39, n=22 syllabi) and in the healthcare area - Speech Therapy (L/SNT2, n= 73 syllabi) and Physiotherapy (L/SNT2, n=42 syllabi) - for a total of 156 syllabi analyzed at the University of Trieste. The corpus comprises the entirety of available syllabi for each three-year programme, restricted to TAF A (basic disciplines), B (core/characterizing disciplines) and C (related and integrative disciplines), as these constitute the professionalizing component of each pathway.
Syllabi have been treated as artefacts of didactic design [4], [5]: documents in which lecturers render visible - or leave implicit - their formative choices regarding learning objectives, teaching strategies and assessment criteria. The constructive alignment model [5] defines the quality of curricular design as coherence between these three components and provides the analytic framework for reading the syllabus. Soft skills were searched across the entire text of each syllabus - course description, disciplinary content, learning objectives, teaching methodologies and assessment methods - since they may emerge in any section: the unit of analysis is therefore the syllabus.
The analytical framework was built through an inductive process conducted directly by the researcher in three stages: integral and recursive reading of each syllabus with collection of all textual expressions related to soft skills; systematic comparison of labels in a spreadsheet to identify cross-cutting recurrences; aggregation into categories by frequency and semantic proximity. This process led to the identification of 13 categories; communication; planning; analytical skills; critical thinking; teamwork; discussions; reworking; sector-specific language; reflective; comprehension; empathic; application and judgement skills. Each occurrence – explicit, when named in the objectives, or implicit when inferable from methodologies and content - was assigned the value 1. The final score is the sum of occurrences: it returns the qualitative pervasiveness of the phenomenon in the document rather than a quantitative measurement.
The second phase involves phenomenographic interviews with lecturers from the selected programs. For the humanities area, interviews have been fully conducted and analyzed; for the healthcare area, the process is not yet complete. The presentation of the humanities area therefore serves a dual function: it returns the specific findings of that area and acts as a methodological model, exemplifying how the presence, absence and forms of explication of soft skills in the syllabus are illuminated through the voices of the lecturers. Interviews are anonymised with the coding system described in the methodological note and used as interpretative lenses for documentary data: instruments for making visible what the syllabus cannot capture.

3. Syllabus Analysis

3.1 Education Sciences: Profile by Year of Study

The graphics (Fig.1-3) illustrate the distribution of soft skills by subject and year. The most significant data are discussed in the text; for a complete reading the reader is referred to the figures. Placement, which in the Education Sciences programme falls under F credits rather than TAF A-B-C - lacks a formal syllabus and does not appear in the documentary analysis. This structural absence is itself a significant interpretive finding and will be addressed in Section 4.
In the first year (cf. Fig.1), signature pedagogies are oriented primarily towards building disciplinary language: the integrated course in General Pedagogy and History of Pedagogy (TAF A) reaches 9 for sector-specific language skills and 8 for reworking Psychology of the Life Cycle (TAF A-B) presents the highest score of the year for reworking, 11; and planning, 7. Teamwork is almost absent: maximum value 4, 0 in most subjects.
In the second year (cf. Fig. 2) the profile becomes more articulated: Early Childhood Pedagogy and Children's Literature (TAF B-C) reaches 10 for reworking and 5 for planning; Educational Planning and Evaluation (TAF B) presents the highest teamwork value across the entire three-year programme, 5, signalling that core methodological subjects constitute the curricular space where collaborative competences find their most explicit expressions.
In the third year (cf. Fig.3), the syllabus analysed belongs to TAF A, B and C; programme credits are also distributed across placement activities which as noted lack a formal syllabus. Among the syllabus recorded, Experimental Pedagogy (TAF A) presents the richest profile with 4 for analytical skills and 2 for reflective skills.

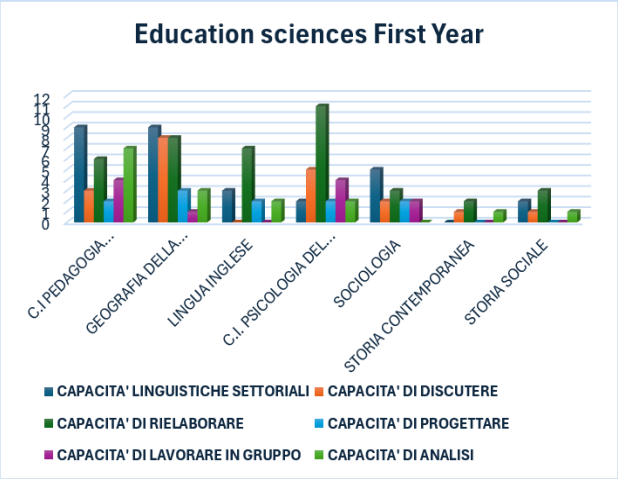


Fig. 1. Distribution of Soft skills in Education Sciences-first Year

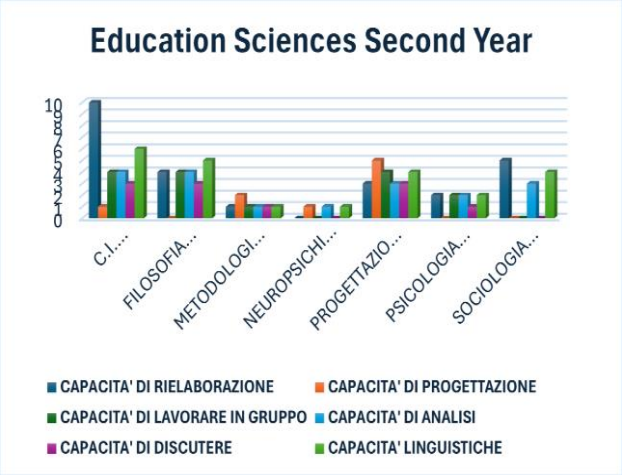


Fig. 2. Distribution of Soft Skills in Education Sciences-Second Year

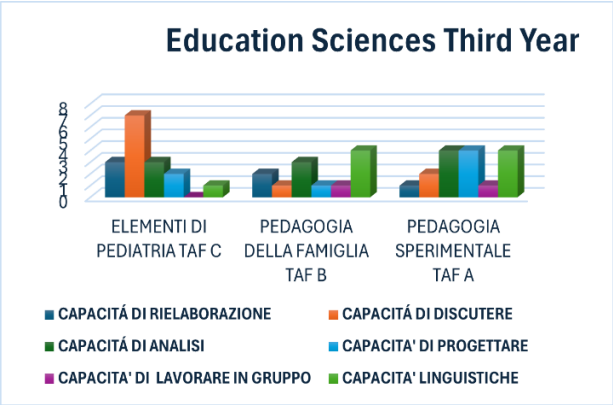


Fig. 3. Distribution of Soft Skills in Education Sciences-Third Year

3.2 Social Work: Profile by Year of Study

The graphics (Fig.4-6) below illustrate the profile of the Social Work degree programme. The documentary analysis was conducted on the academic year 2024/2025.
In the first year (cf. Fig.4), relational soft skills appear more explicitly than in Education Sciences: Methods and Techniques of Social Work1 (TAF B) reaches 7 for communication skills, 4 for critical thinking and 4 for teamwork.
In the second year (cf. Fig.5), the integrated course in Social Policy (TAF A) reaches 6 for communication skills. Two second-semester subjects do not appear in the analysis because, at the time

of data collection (academic year 2024/2025), the relevant syllabus had not yet been uploaded to the institutional platform as the teaching positions were subject to external contract tenders; this is not a structural curricular gap but a temporal limitation of the documentary analysis.
In the third year (cf. Fig.6), Methods and Techniques of Social Work3 (TAF B) presents 4 for critical thinking and 3 for communication skills and teamwork; one TAF C subject does not appear for the same reasons.

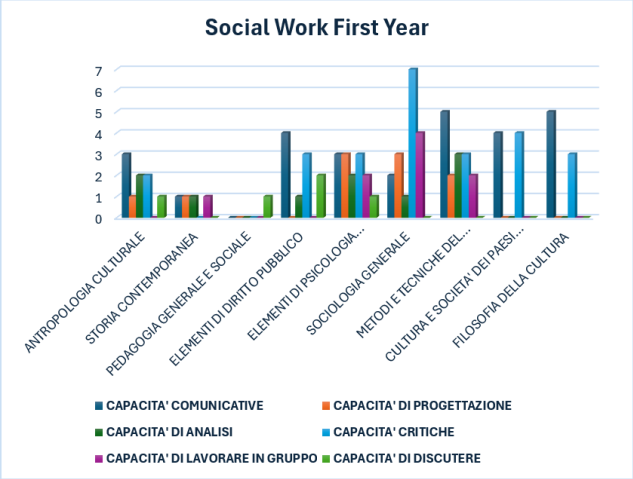


Fig. 4. Distribution of Soft Skills in Social Work

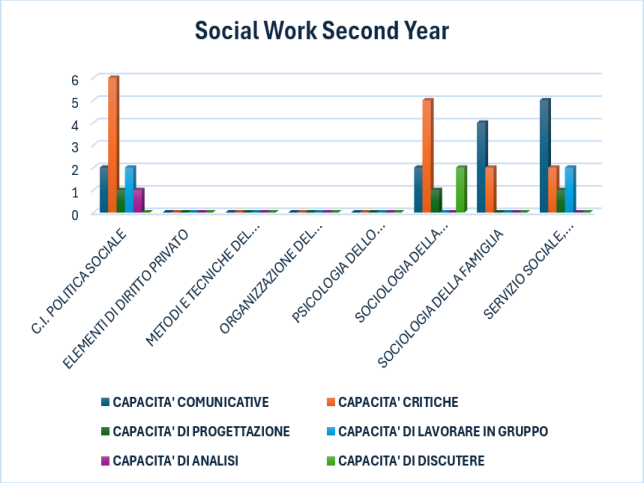


Fig. 5. Distribution of Soft Skills in Social Work

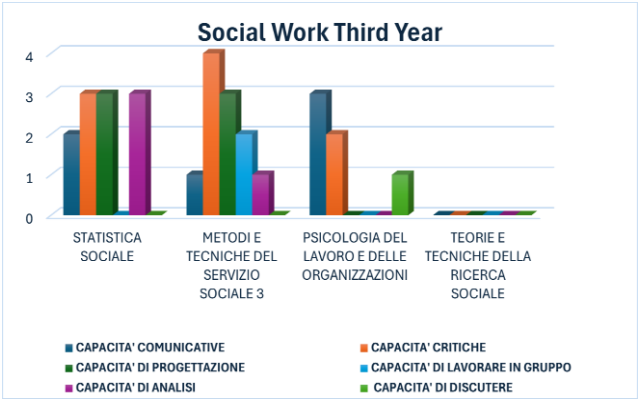


Fig. 6. Distribution Soft Skills in Social Work

3.3 Physiotherapy: Profile by Year of Study

The graphics below (Fig.7-9) illustrate the distribution of soft skills in the Physiotherapy programme. The structurally distinctive element compared to the humanities area is the presence of placement - belonging to TAF B and with its own syllabus structured in the same way as other disciplines - in all three years of the programme.
In the first year (cf. Fig.7), the first-year placement (TAF B) presents the highest values of year; 7 for critical thinking and 5 for language skills, confirming that the practical-situated moment is formally framed as a declared learning objective from the very beginning of the programme. Research Methodology (TAF A) and Human Morphology and Biochemistry contribute balanced scores for critical and analytical skills.
In the second year (cf. Fig.8), the integrated course in General Surgery (TAF A-B) reaches 4 for critical thinking and 3 for reflective and analytical skills. The second-year placement (TAF B) presents 5 for reflective skills and 4 for critical thinking and communication skills.
In the third year (cf. Fig.9), the third-year placement (TAF B) reaches the highest score of the entire three-year programme with 7 for communication skills and 4 for teamwork, demonstrating a coherent progression in which the practical component contributes increasingly to the development of soft skills.

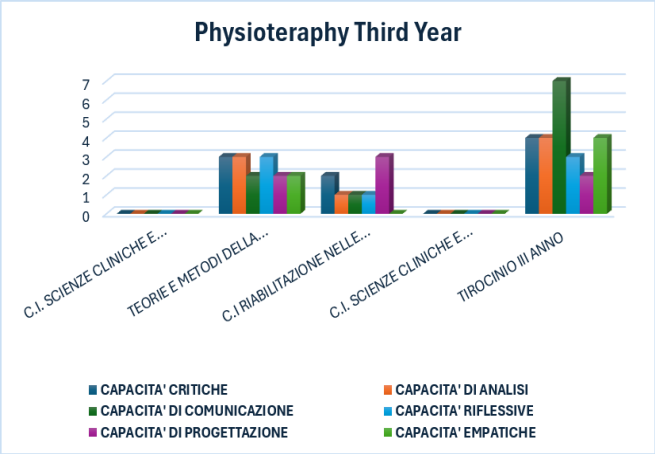


Fig. 7. Distribution of Soft Skills in Physiotherapy

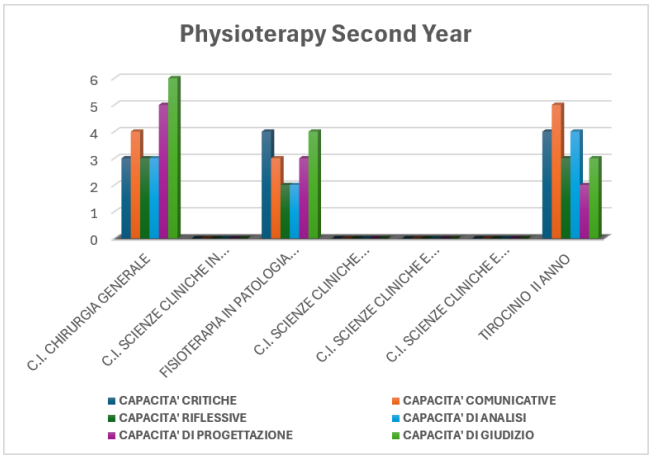


Fig. 8. Distribution of Soft Skills in Physiotherapy

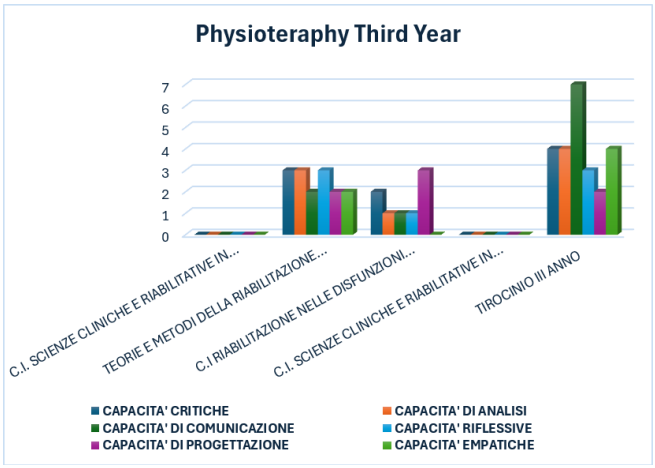


Fig. 9. Distribution Soft Skills in Physiotherapy

3.4 Speech Therapy: Profile by Year of Study

The graphics below (Fig.10-12) illustrate the distribution of soft skills in the Speech Therapy programme, which presents the highest scores in the entire comparative analysis.
In the first year (cf. Fig.10), Human Sciences (TAF A-B) reaches 11 for critical thinking, 8 for communication skills and 7 for sector-specific language skills; Language Development (TAF A-B) contributes 8 for critical thinking and 7 for communication skills. The first-year placement (TAF B) already presents relevant scores in the first year, confirming the centrality of clinical practice from the very beginning of the programme.
In the second year (cf. Fig.11), Neurology and Logopedics of Aphasia (TAF B) reaches 8 for critical thinking and 7 for analytic skills; the 2nd year placement (TAF B) contributes 3 for judgement skills.
In the third year (cf. Fig. 12), Neurological Pathologies (TAF B) reaches 10 for planning skills, 7 for critical thinking and 4 for teamwork; the third-year placement (TAF B) presents 6 for judgement skills and 5 for critical thinking, communication and language skills.

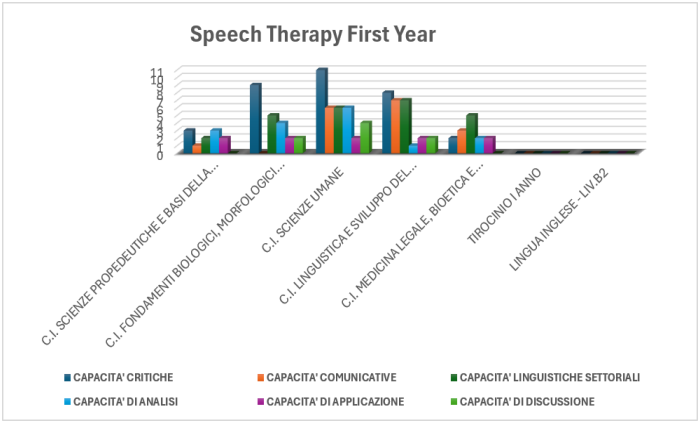


Fig. 10. Distribution Soft Skills in Speech Therapy

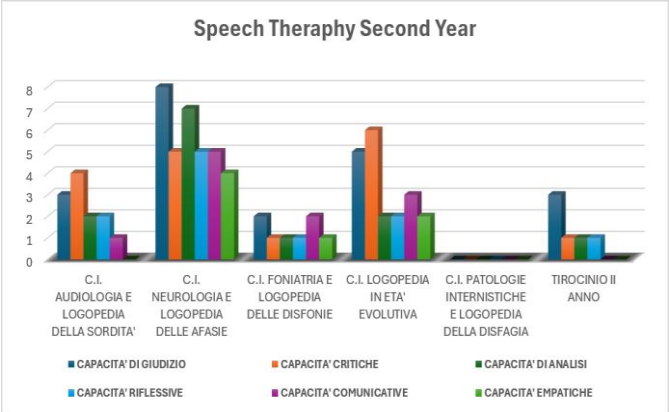


Fig. 11. Distribution soft Skills in Speech Therapy

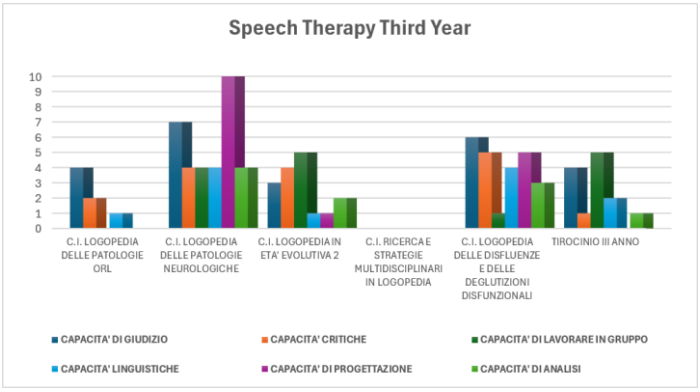


Fig. 12. Distribution Soft Skills in Speech Therapy

3.5 Comparison between the Two Areas

Given the qualitative nature of the scoring system, which captures pervasiveness rather than measuring quantity, aggregate comparisons are intentionally avoided; the asymmetries described are grounded in the patterns observed across the full corpus of 156 syllabi. The comparison between the humanities and healthcare areas reveals three structural asymmetries. The first concerns formalisation: in the healthcare area soft skills are declared explicitly with greater frequency and scores are distributed more evenly across the three years.
The second concerns placement: in the healthcare programmes it is integrated as a curricular device with its own syllabus belonging to TAF B in every year, whereas in Education Sciences it is structurally absent from documentary analysis and in Social Work it is present but with still partial formalisation.
The third concerns progression: the healthcare programmes show a coherent growth of scores from the first to the third year, in which clinical practice contributes increasingly to the development of soft skills: in the humanities area this progression is not detectable in the documents.

4. The Signature Pedagogies of the Humanities Area: What the Syllabus Does Not Tell

Documentary analysis returns what lecturers have chosen to write. Phenomenographic interviews give access to what the syllabus cannot capture: the conceptions, practices and tensions inhabiting professional training. The connection between documentary data and lecturers' voices is the central interpretive device of this section; for each thematic node, the analysis begins from the specific syllabus data of the interviewed lecturer and enters their voice as explanation, confirmation or contradiction of that data.

4.1 Soft Skills as Constitutive of the Profession

The syllabus documents of both programmes show soft skills predominantly implicit in methodologies. This implicit presence is not accidental; it reflects a conception in which soft skills are not additional to

technical knowledge but constitutive of it. A lecturer (DLSE_02) - whose syllabus includes explicit objectives for professional communication and teamwork - articulates these with precision:
"I don't distinguish between soft and hard skills; soft skills are part of the technical competences of educators. They are concerned about the very heart of educational work. They are indispensable cogs, not decorations."
In the Social Work programme, a lecturer (DLSS_03) - whose first-year syllabus shows significant scores for communication and analytical skills - draws the crucial distinction between relational competence as a personal disposition and as a conscious methodological acquisition:
"In active listening I must be able to reformulate to stimulate the other's narrative. In the profession I am aware of the competence I am using at the moment because I have acquired a method."
This distinction is epistemologically significant: university training is called not to form "relationship-gifted" people, but professionals who consciously master their soft skills as tools of their work.

4.2 The Gap between What Is Practiced and What Is Written

The most recurrent finding in the analysis is the gap between rich teaching practices and syllabus that don't declare them. A lecturer (DLSE_04) - whose 3rd year syllabus reaches 4 for analytical skills, the highest score of the year, through explicit formulation in the Dublin Descriptors - represents the case of coherence between document and practice:
"I made them explicit within the learning objectives: knowledge and understanding is a transversal capacity; autonomy of judgement is explicit. It isn't difficult to do it - you just have to decide to do it."
By contrast another lecturer (DLSE_05) – whose second-year syllabus shows group activities in the methodologies but no soft skills in the objectives – states:
"In my syllabus soft skills aren't present. Final exams are based on content: I don't assess soft skills because I haven't declared them as an objective."
The same gap emerges in the Social Work programme: a lecturer (DLSS_02) practices case analysis in small groups daily - whose syllabus shows significant scores for communication and teamwork - but when asked about soft skills in the syllabus indicates she would need to check. Another lecturer (DLSS_01) identifies the structural reason for this fragmentation:
"Building a transversal pathway means entering into dialogue between lecturers. We often cannot do this not because we don't want to but because institutional time doesn't allow it."

4.3 Active Teaching as Signature Pedagogies in Action

The highest teamwork scores are concentrated in methodological, and laboratory subjects. Interviews reveal the didactic logic underlying these scores - logic that syllabus cannot capture. A lecturer (DLSE_03) - whose syllabus presents the highest teamwork value across the entire three years programme - explains:
"Soft skills cannot be taught frontally: made explicit, they become trivialized. I ask students to work in a small group on a real planning project, through all its phases. If I ask the questions, they already have an answer; if they ask themselves, they discover they need to adjust many things."
In the Social Work programme, a lecturer (DLSS_02) - whose syllabus shows balanced scores for communication and teamwork - describes a teaching that reproduces real professional work conditions:
"I bring a real case; we analyse it together in small group stimulating teamwork: that is what they will be doing. Working together to solve a problem is already forming for the profession."
Both practices correspond to what Shulman calls the surface level of signature pedagogies: the visible teaching acts through which the values and epistemologies of the profession are transmitted in an embodied way. That these practices are scarcely documented in the syllabus is the central contradiction of the humanities area.

4.4 Placement: Structural Absence and A Vision to Build

Placement is the formative device in which signature pedagogies would find their fullest expression. Its absence from the Education Sciences syllabus is not bureaucratic oversight: it is the symptom of a deeper problem. A lecturer with a placement coordination role (DLSE_01) articulates this clearly:
"We do not have a single shared placement model across Italian Education Sciences programmes. The fundamental question is: what idea, what vision, what model of placement do we have? When we have this shared thinking, we will be able to establish which soft skills to develop and how."
Another lecturer (DLSE_03) articulates the problem in didactic terms:

"There is a gap between placement and courses. Without this integration I must work on students' imaginative capacity. With integrated placement we would have a real training ground."
In the Social Work programme, placement is present from the first year, but a lecturer (DLSS_04) notes that the systematic focus on soft skills still depends on individual supervisors rather than a shared framework:
"From the first-year students have a placement in which they practise these competences. I am not sure how much tutors have a specific focus on these. They are competences the social worker cannot do without - but there is not yet a shared model for developing them."

5. Discussion and Conclusions

The research shows that the humanities area possesses recognisable signature pedagogies - oriented towards relationship, reflexivity and situated planning - but that these exist predominantly in lecturers' practices not in the official curricular documents. This gap has three concrete implications for curricular design.
The first concerns syllabus as pedagogical acts. What is not written cannot become a shared objective, cannot be systematically assessed, and does not orient students as a declared formative goal, particularly in a Higher Education context increasingly oriented toward measurable learning outcomes [7]. Making soft skills explicit in the syllabus does not mean bureaucratising teaching: it means rendering visible and transmissible a signature pedagogy that already exists in the classroom. As the case of DLSE_04 demonstrates - the only lecturer who has systematically made soft skills explicit through the Dublin Descriptors - this formalisation is possible and does not impoverish practice.
The second concerns placement as a curricular device. The recent establishment of the professional register for educators (Law 55/2024) opens a normative space in which it is finally possible - and necessary - to build a shared placement model with declared learning objectives and measurable soft skills, following the model already in place in the healthcare programmes with placement belonging to TAF B. Without this step, the formative device most directly involved in building professional identity will remain without an explicit reference framework.
The third implication concerns shared curricular design. The gap between practices and documents, and the fragmentation between courses, are not individual problems: they are effects of an institutional structure that does not provide time and spaces for pedagogical dialogue between lecturers. As DLSS_01 notes, building a transversal pathway requires dialogue – dialogue that is not yet systematically possible. The research will continue with the analysis of interviews with lecturers in the healthcare area, to examine whether and to what extent greater documentary formalisation is accompanied by a different conception of the role of soft skills in professional training.

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Associations between Job Satisfaction and Dimensions of Work Motivation and Emotional Exhaustion in Pre-University Education Workers

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Abstract

In the occupational environment, workers' motivation and satisfaction are essential for their work performance. In the occupational school environment, emotional exhaustion can lead to a decrease in workers' performance. The associations between motivational dimensions and those of job satisfaction as well as their associations with the burnout score in workers from 3 school units (a high school, a kindergarten and a middle school) were monitored during periodic medical check-ups using the following questionnaires: The Multidimensional Work Motivation Scale, The Job Satisfaction Survey, Oldenburg Burnout Inventory. There are numerous associations between motivational and job satisfaction dimensions, as well as between these and burnout scores and socio-demographic indicators. These associations are frequently different depending on the school unit. In the 3 schools, workers have low levels of burnout emotional.
In all 3 schools, the following similar correlations are remarkably observed between the following variables:
-Intrinsic motivation correlates positively with Satisfaction with Pay (p1=0.005; p2=0.007; p3=0.002) and with Satisfaction with Fringe Benefits (p1=0.015; p2=0.028; p3=0.026);
-Amotivation correlates negatively with Job Satisfaction Survey scale score (p1=0.016; p2=0.008; p3=0.004)Ş
-Burnout score correlates positively with Satisfaction with Coworkers (p1<0.001; p2=0.019; p3=0.002) and with Satisfaction with Communication (p1<0.001; p2=0.018; p3=0.003).
For school workers, low levels of emotional exhaustion are associated with satisfaction with Coworkers and Satisfaction with Communication. The school occupational environment being one
in which communication as well as social interrelations represent the environment and object of work, worker involvement, good communication and collaboration with other actors of the educational act in school manifest themselves in the initial stages of the burnout syndrome.
Lack of motivation at work is bidirectionally associated with a decrease in employee job satisfaction.
The vocational motivation of school workers increases if these workers receive material benefits or incentives of another nature. Even for teachers who exercise their work by vocation, a decrease in remuneration or other incentives or benefits can lead to a decrease in their motivation and involvement in the educational act.

Keywords: *school, workers, job satisfaction, work motivation, burnout*

Introduction

In the educational environment, the quality of the learning process, the performance of employees depends primarily on their involvement, their motivation in the educational process. It is known that emotional exhaustion can lead to a decrease in workers' performance. A good job satisfaction of workers stimulates their motivation and involvement in obtaining good results.
In psychology, the theory of self-determination shows that well-being and performance are greater when individuals' actions are guided not so much by external factors but by will and pleasure, through the so-called intrinsic motivation [1]. The individual pursues his fundamental needs for autonomy, competence and relationships having the following ways of regulating motivation:
-amotivation which shows the lack of any motivational impulse. The teacher does not obtain satisfaction in the teaching activity which can lead from low performance to career abandonment;
-extrinsic motivation in which actions pursue a material reward or social recognition (or obligation);

-controlled motivation (or regulated by introjection) the individual assimilates rules and values and obeys them because they consider them important even though they do not necessarily belong to their own value system. Motivation regulated by introjection is a form of extrinsic motivation in which workers are driven by the desire to maintain their good image in society, self-esteem, fear of failure or feelings of guilt without being convinced of the intrinsic value of the activity performed;
-motivation regulated by identification in which the individual's actions have personal significance and value. Workers perform certain activities or behaviors because they consider them valuable and integrate them into their own professional value system, not necessarily out of pleasure. When the results of their activity bring them lasting satisfaction and pleasure, they can move to the higher stage of intrinsic motivation;
-intrinsic motivation in which the individual's actions are performed with joy, passion and interest. Intrinsic motivation is manifested by the worker through passion, enthusiasm, curiosity and professional development. The decrease in external, social or material support can diminish enthusiasm without the worker giving up involvement in the activity at work.
Although for teachers the teaching activity is considered a vocational one, through intrinsic motivation, external factors (social and material) have an important role in maintaining motivation and involvement in the profession in the long term. External, extrinsic motivation is based on both financial rewards (remuneration through salary or bonuses for seniority or performance), the provision of modern teaching aids (digital platforms, computers) and valuation from society (esteem from parents, the community, school management). It is important to know if there are associations between certain dimensions of motivation and those of Job Satisfaction as well as between these and the Burnout syndrome [2], [3]. Well-motivated teachers can increase the quality of the educational act and the performance and school efficiency of students.

Material and Methods

During the medical check-up of workers from 3 school units, namely a high school, a middle school and a kindergarten, all located in urban areas, they were offered a voluntary questionnaire that monitored, along with socio-demographic variables (age, length of employment in the school, biological gender, type of residence), the type/types of motivation of workers at work, types of job satisfaction as well as the presence of emotional exhaustion in them.
Workers' motivation at work was evaluated through The Multidimensional Work Motivation Scale (MWMS), having 19 items with answers on a Likert scale from 1 to 7. This scale has 6 dimensions representing the types of motivation, namely: Amotivation, Extrinsic regulation (social), Extrinsic regulation (material), Introjected regulation, Identified regulation, Intrinsic motivation. Except for the Introjected regulation dimension which has 4 items, the other dimensions each have 3 items. The maximum possible score of these dimensions is 21 except for the Introjected regulation dimension which can achieve a maximum of 28 points [4].
Burnout syndrome was assessed in workers using the Oldenburg Burnout Inventory, a questionnaire that has 16 items on a 4-point Likert scale and presents 2 dimensions of burnout syndrome, namely Disengagement and Exhaustion. The maximum total possible score on this scale is 64, each of the 2 dimensions, Disengagement and Exhaustion, can achieve a maximum score of 32 [5], [6]. .
The Job Satisfaction Survey was used to assess the ways of satisfaction of workers at work. With 36 items, each scored on a 6-point Likert scale, this questionnaire tracks the following types of Satisfaction, namely: Pay, Promotion, Supervision, 3, Fringe Benefits, Contingent Rewards, Operating Conditions, Coworkers, Nature of Work, Communication. Each dimension, having 4 items, can achieve a maximum of 24 points. The maximum possible score of the Job Satisfaction Survey is 216 [7], [8].

The questionnaire was administered for voluntary completion to workers in a high school (School no. 1), a kindergarten (School no. 2), and a middle school (School no. 3) which together totaled a total of 184 employees. The distribution of the number of workers and respondents in each school is as follows:
-in School no. 1 there are 89 employees with 76 respondents;
-in School no. 2 out of 37 employees there were 18 respondents;
-in School no. 3 with 58 employees presented 47 respondents.
Respondents are predominantly female in all 3 schools (Table 1).

Table 1. Percentage of respondents by gender within respondents

gender	School no. 1	School no. 2	School no. 3
women	69.74	100	82.98
men	30.26	0	17.02

The respondents' type of residency is predominantly urban in all 3 schools (Table 1).

Table 2. Percentage of respondents by type of residence within respondents

type of residence	School no. 1	School no. 2	School no. 3
urban	95.77	58.82	78.72
rural	4.23	41.18	21.28

Results

The workers are on average in middle adulthood, at which point they generally reach a maximum professional level. The average length of experience at the current job between 5 and 13 years shows a good professional experience as well as a stability of these workers at the current job. (Fig. 1.)

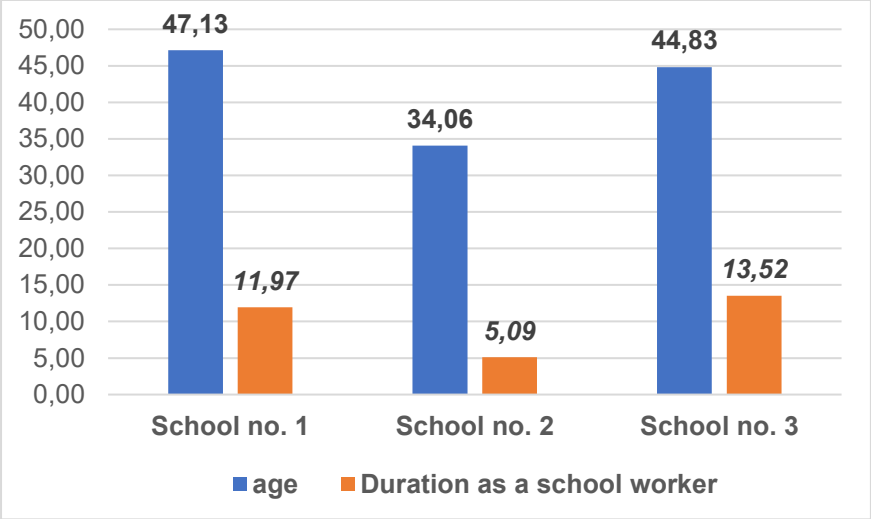


Fig. 1. Age and duration as a school worker by school

Low-average burnout levels in the state for the total score as well as the 2 subdimensions are present in workers from the 3 schools. (Fig. 2.)

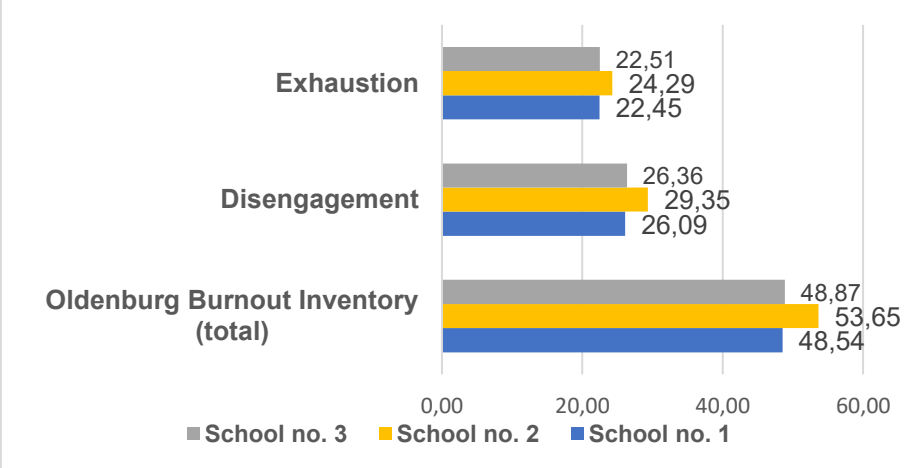


Fig. 2. Average levels of burnout score dimensions in the 3 schools

Workers from the 3 schools have higher scores on Intrinsic motivation and Identified regulation, while also achieving the lowest scores on amotivation. (Fig.3)

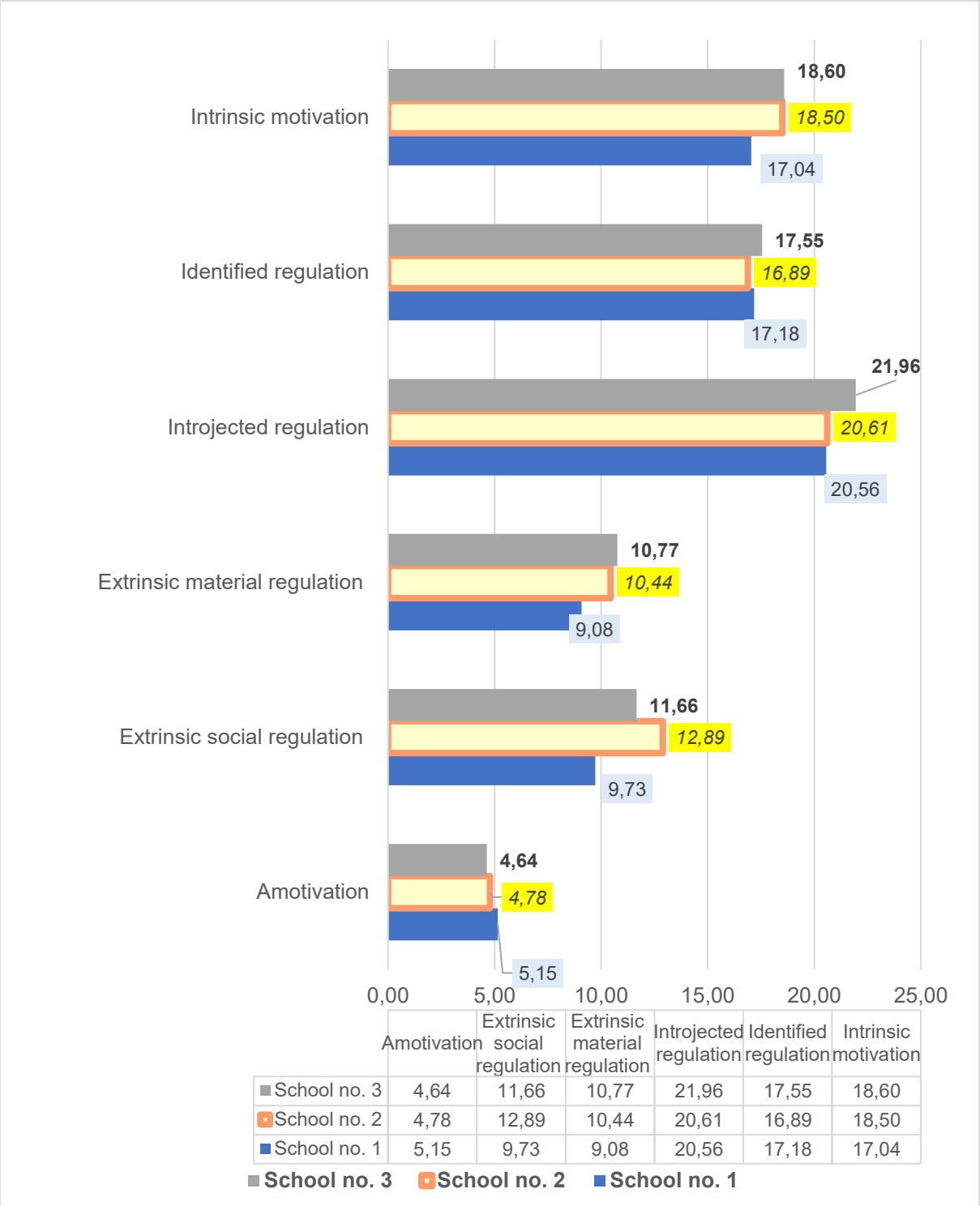


Fig. 3. The average scores on the Multidimensional Work Motivation Scale for workers from the 3 schools

The scores on Introjected regulation are higher due to the fact that this scale has 4 items compared to the others which only have 3 items.
The average scores of the dimensions of the Job Satisfaction Survey scale are shown in the following figure (Fig.4.)

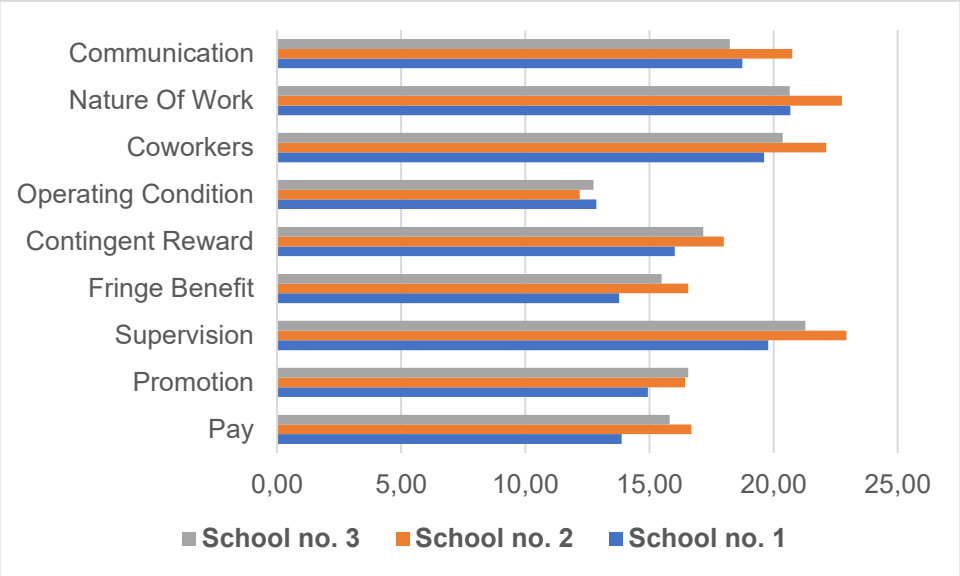


Fig. 4. Average scores of the Job Satisfaction Survey dimensions in the 3 schools

The highest scores are obtained for satisfaction with supervision, nature of works, coworkers, communication and the lowest value for operating condition.
There are numerous different correlations between the studied variables depending on the school unit. There are also correlations present similar in all 3 school units that show the generalizability of these results.
In all 3 schools, the following similar correlations are remarkably observed between the following variables:
-Intrinsic motivation correlates positively with Satisfaction with Pay (p1=0.005; p2=0.007; p3=0.002) and with Satisfaction with Fringe Benefits (p1=0.015; p2=0.028; p3=0.026);
-Amotivation correlates negatively with Job Satisfaction Survey scale score (p1=0.016; p2=0.008; p3=0.004)
- Burnout score correlates positively with Satisfaction with Coworkers (p1<0.001; p2=0.019; p3=0.002) and with Satisfaction with Communication (p1<0.001; p2=0.018; p3=0.003).
For school workers, low-medium levels of emotional exhaustion are associated positively with satisfaction with coworkers and satisfaction with communication.

Conclusions

Workers from all 3 schools have as main dimensions of motivation introjected regulation, Intrinsic motivation, Identified regulation. Among the smallest motivational dimensions are social and material Extrinsic regulation and the lowest modality of motivation is amotivation. The concordant values obtained in the 3 schools on the presented dimensions show a general character of these results.
Satisfaction with supervision, nature of works, coworkers and communication being the most important dimensions (modalities) of job satisfaction show a vocational occupational environment and good communication with colleagues and hierarchical superiors and which are appreciated by workers from these schools.
The smaller sources of satisfaction compared to the first ones being Fringe Benefits, Pay, Promotion indicate the importance of improving the organizational aspects of stimulating performance and promotion based on performance criteria in the school as well as of the appropriate remuneration for the work performed. The fact that operating condition has the lowest values supports the importance of involving decision-makers, from society, in improving and creating better working conditions as a premise for obtaining performance from workers in the educational act. The similar values obtained in the 3 schools show that the aspects presented are not accidental but allow their generalization.
For school workers, having low-medium levels of emotional exhaustion are associated positively with satisfaction with Coworkers and Satisfaction with Communication. In schools, workers who have higher levels of job satisfaction in terms of satisfaction with collaboration with other employees and communication with other actors in the educational act (colleagues, students) achieve higher levels of burnout syndrome score. The relationship is bidirectional, workers with higher levels of burnout score

present greater job satisfaction in terms of collaboration with other employees and communication with participants in the educational act (colleagues, students).
The school occupational environment being one in which communication as well as social interrelations represent the environment and object of work, worker involvement, good communication and collaboration with other actors of the educational act in school manifest themselves in the initial stages of the burnout syndrome.
Lack of motivation at work is bidirectionally associated with a decrease in employee job satisfaction.
The vocational motivation of school workers increases if these workers receive material benefits or incentives of another nature. Even for teachers who exercise their work by vocation, a decrease in remuneration or other incentives or benefits can lead to a decrease in their motivation and involvement in the educational act.

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Understanding Nursing-Specific Polysemous Terms: An Exploration with Hong Kong L2 Nursing Students

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Abstract

Extensive research has been conducted on the discipline-specific vocabulary required by students across different fields. In nursing, certain general English words are polysemous, such as the term 'line(s)' may acquire specialized meanings through figurative extensions to convey nursing knowledge. For L2 English learners (learning English as a second language), recognizing and understanding these ordinary yet polysemous nursing-specific terms can be challenging. Investigating how these terms convey nursing knowledge and identifying the difficulties faced by L2 nursing students contribute to improving the teaching and learning of nursing-specific vocabulary, thereby enhancing their expertise and the provision of healthcare.

To this end, a two-phase study was conducted. The first phase involved investigating the knowledge embedded in the general English polysemous term, 'line(s)', as found in the Oncology Corpus compiled for this study. The second phase consisted of a survey aimed at exploring the challenges Hong Kong L2 nursing students when interpreting the figurative meanings of the term 'line(s)' within the nursing context.

The first phase of the study reveals that the term 'line(s)', an ordinary English word, frequently has its multiple meanings extended through metaphor and metonymy. The findings indicate that 'line(s)' commonly appears in universal metaphors such as the pathway to convey nursing knowledge. Furthermore, the term occurs in many general English idiomatic expressions and functions as an important nursing-relevant linguistics resource in nursing workplace spoken communication. The survey with ninety nursing students indicates that their awareness of the figurative extensions of this polysemous term needs to be strengthened. Some participants underinterpreted or misinterpreted its nuanced meanings. The findings also reveal cultural variations and first language influence in participants' interpretation of the term when it is extended figuratively.

It is recommended that seemingly general but figurative polysemous terms, such as the term 'line(s), be explicitly addressed in nursing curricula. Instruction should focus on detailed metaphorical mappings to support nuanced understanding of nursing knowledge. Teachers should also attend to cultural differences and first-language influences among L2 learners, which may shape their interpretation of these figurative extensions. In sum, these measures can promote greater precision in healthcare practice and enhance patient safety.

Keywords: *Discipline-specific polysemous terms, nursing-relevant linguistic resources, idiomatic expressions, figurative expressions, health-care communication*

1. Introduction

Since the inception of English for Specific Purposes (ESP) as a distinct field, considerable research has been devoted to examining discipline-specific vocabulary [18][20][23]. This vocabulary encompasses important concepts and specialized knowledge unique to a particular field. Proficiency in this vocabulary is essential for students' academic success and their ability to perform appropriately and effectively in future professional settings. In the field of nursing, the acquisition of discipline-specific medical terminology serves as a key indicator of nursing students' understanding of their field's specialized knowledge. It is integral to their professional identity and also plays a crucial role in fostering workplace competence. Proficiency in this terminology enables nursing students to communicate accurately and appropriately with both healthcare professionals and patients, carrying out clinical responsibilities with precision, and ultimately contribute to ensuring patient safety [2][10].

[20] classifies vocabulary for English learners in academic contexts into four categories: high-frequency words, technical words, academic words, and low-frequency words. In the nursing field, the Unified Medical Language System (UMLS), a resource for health and biomedical informatics, includes 1,208 multiply-categorized vocabularies and terminologies, illustrating various types of polysemy in healthcare

contexts [19]. Some of these polysemous terms are high-frequency general English words, adopting specialized meanings in the nursing field. Nevertheless, there is a general tendency for students to overlook the important nursing knowledge embedded within these seemingly ordinary English terms, particularly given their polysemous nature.

As [24] point out, the various senses of a polysemy can be classified into two broad categories: core meanings, which encompass general and familiar interpretations, and non-core meanings, which include peripheral or extended interpretations. Non-core meanings are often new senses derived metaphorically or metonymically from the core meanings [7][22]. Generally, metaphor involves a comparison between two entities, while metonymy relies on contiguity relationships between a component and the object it represents. It has been well-documented that metaphor and metonymy are employed by different disciplines to frame the knowledge and social world of their fields [6][9], as well as building the identity and sharing the values of a discourse community [5]. For instance, the 'pathway' metaphor is frequently employed by the healthcare professionals taking care of end-of-life cancer patients to express their views about the lengthy nature of cancer treatments [21]. In cognitive linguistics, metaphor is understood as systematic comparisons between two conceptual domains, namely the source and the target domains, rather than a mere comparison between two discrete entities. As exemplified by the conceptual metaphor 'life as a journey', where elements of the source domain 'journey', such as 'distance', 'obstacles' and 'different paths' are systematically mapped onto aspects of the target domain 'life', such as 'longevity', 'difficulties', and 'different decision-making' [12][25].

Another example illustrating how a general English polysemous word can acquire discipline-specific meanings through metaphor or metonymy in the nursing context is the term 'line(s)'. The general English word 'line', which ranks 274th among the 2801 high-frequency headwords in the New General Service List (NGSL) [4], literally refers to a physical line or a line-shaped entity. In the nursing context, the term 'line(s)' refers to the equipment catheter lines (also as 'tubes') used in intravenous therapy. For example, the term 'PICC lines' (Peripherally Inserted Central Catheter lines) is a device in administering intravenous therapy. Furthermore, its meaning can also be extended metaphorically to denote types or methods, as seen in expressions such as 'many lines of treatment'. Certain meanings of 'line' can also evolve into what is described as 'a metaphor from metonymy', as illustrated by the example of 'advice line', which is further discussed in Section 4. Notably, some of these extended senses tend to be associated with particular grammatical patterns [16], such as the singular form of 'mouse' instead of the plural form 'mice' is more likely to be extended as a computer device in Computer Science.

In sum, it is important for nursing students to recognize that certain seemingly ordinary English words may function as discipline-specific polysemous terms through figurative extensions. Developing competency in interpreting both the literal and figurative meanings of these discipline-specific polysemous terminologies, such as 'line(s)' within the nursing context, is crucial. This competency facilitates a deeper understanding of nursing knowledge, promotes effective and precise engagement in professional discourse, and thereby enhances their workplace performance and patient safety.

Nevertheless, L2 learners (learners of English as a second language) often rely on the core meaning - usually the literal sense - of a polysemous word to interpret a text or context. When general English words acquire new meanings through metaphorical or metonymical extensions, this can create comprehension challenges for L2 learners [8]. The problem becomes more complex when both the literal and figurative senses of a general English polysemous term are frequently used in discipline-specific writing since students are required to master not just the multiple meanings of a discipline-specific term, but also metaphoric competence to help them discern whether the literal or figurative sense of the term is applied in a specific text or context. One example is the difficulties faced by L2 nursing students in interpreting polysemous terms in nursing questions in their examination, as [1] explain. [13] also observed that Computer Science students in her study struggled to understand the term 'data field' because they were more familiar with the general literal meaning of the word 'field' in the agricultural sense. Furthermore, comprehension and interpretation problems may arise not only with single-word polysemy but also when they occur in multi-word units. [17] identifies the difficulties that a group of Bangladeshi ESP students experienced when they encountered the metonymic term '*can do* civil servants' which refers to a set of civil servants with a particularly positive attitude; the Bangladeshi students thought it simply meant 'capable' civil servants since they attempted to understand the meaning of 'can do' separately and were not aware that an extended metaphorical meaning has been assigned to the two words when they appear as one multi-word unit.

2. Objectives and Research Questions

Considering these challenges, this paper aims to explore the potential difficulties faced by L2 nursing students in Hong Kong when interpreting general English polysemous words as nursing-specific terms. The focus of this study is placed on how the ordinary English polysemous term 'line(s)'is extended through metaphor and metonymy in oncology nursing research articles. Oncology nursing research articles have been selected for this study due to the increasing significance of cancer as a global health threat and the important role of catheter lines, commonly referred to as 'line' in the administration of cancer treatments. Through exploring the potential challenges that L2 nursing students in Hong Kong encounter when interpreting this discipline-specific polysemous item, particularly within the context of oncology nursing, it is hoped that the findings can provide pedagogical insights into helping Hong Kong L2 nursing students in understanding nursing discipline-specific polysemous items more effectively.
The research questions guiding this study are:

1. What kinds of knowledge related to nursing, particularly oncology nursing, are encoded through the polysemous term 'line(s)' in oncology nursing research articles?
2. What potential challenges L2 nursing students in Hong Kong face in understanding the meanings of this general English polysemous is extended as discipline-specific polysemous term, especially when these meanings are motivated figuratively, by metaphor or metonymy?

3. Methods

To answer the two research questions, research articles containing the words 'cancer', 'care', 'healthcare', 'nurse(s)', 'oncology' and 'patient(s)' extracted from the *European Journal of Oncology Nursing* and *Cancer Nursing Practice* between 2010 and 2016 were downloaded, which were compiled into a corpus called the Oncology Corpus (ONCO Corpus). The total number of words in this corpus is approximately 1.05 million. With the assistance of the corpus tool named *AntConc*, the instances containing the term 'line(s)' were displayed in key words in context format (KWIC) [3].
There are in total 284 instances of 'line(s)' in the Corpus. In general, it has been observed that the multiple meanings of this term within the nursing context can be categorized into three major types: i. a specialized term within the nursing context, ii. an academic term in academic writing and, iii. other less frequent applications (please refer to Figure 1 below). The focus of Section 4.1 is on the first category, that is, the specialized knowledge related to nursing, particularly oncology nursing, as encoded through the polysemous term 'line(s)' in oncology nursing research articles compiled for the Oncology Corpus (addressing Research Question 1). Subsequently, Sections 4.2 and 4.3 examine the procedures and findings of a survey conducted among ninety university nursing students in Hong Kong. This survey aims to explore the challenges faced by these L2 nursing students in Hong Kong when interpreting the meaning of this discipline-specific polysemous term, particularly when these meanings are figuratively motivated by metaphor or metonymy (addressing Research Question 2).

4. Results

4.1. Nursing Knowledge Particularly Oncology, Encoded through the Polysemous Term 'Line(S)'

Examples	Meanings of 'line(s)' (frequencies in brackets)	Literal/Figurative
I. As a specialized term within the nursing context (158)		
a. Related to professional role of nurses		
e.g.,1 '…effective psychological support can be partially provided by **front line** cancer nurses.'	-nurses in direct patient/primary care role	Metaphor
e.g.,2 'who do not work consistent **line**'	-irregular work patterns/shifts /teams	Metaphor
b. Related to intravenous therapy		

e.g.,3 'receiving **many lines** of treatments…'	-methods/ types	Metaphor
e.g.,4 'Dacarbazine is the drug of choice for **first-line treatment**…'	-Priority/sequence of the treatments provided	Metaphor from metonymy
e.g.,5 …symptoms arose for these three patients at cycle one, but **the PICC line** was not inserted until cycle three. e.g.,6 …retrograde back up of stagnate blood clot into **lines**… e.g.,7 'Two centers give locks with gentamicin in case of positive **line cultures**.'	-Referring to the medical devices(catheter) for intravenous therapy -The presence of microorganisms (infection) from a catheter ('line)	Literal
c. Related to workplace nursing spoken communication		
e.g.,8 'Keeping **lines** of communication open and being honest enhances trust between healer…'	-maintaining communication channels	Metaphor
e.g.,9 '…stay on the **line'**	-via telephone: non-face-to-face communication	Metaphor from metonymy
e.g.,10 'Because I had almost a terror to say: I came to **the finishing line**.'	-Idiom / Euphemism: 'came to the endpoint of life'	Metaphor
e.g.,11 'when the **line** would be drawn…'	-Idiom / Euphemism: When it is the time to establish a boundary or make a decision (stop treatment)	Metaphor
II. As a word/ phrase in academic writing (118)		
e.g.,12 'This is **in line with** previous research showing that fear of …'	-Consistent with what has been previously found	Metaphor
e.g.,13 'The data were then examined **line-by-line**, and statements and phrases …'	-Referring to careful manners when investigating data	Metaphor Literal
e.g.,14 'Note how Sarah uses the future progressive tense in **line** four in …' e.g.,15 'This numerical rating scale comprises a **5-point horizontal line**, ranging from 0 (no information needed) to 4 …'	-Referring concretely to each physical or textual line of a text / in a graph	Metaphor from metonymy
e.g.,16 'as a larger cohort study in which all the women had answered **a base-line** questionnaire…'	-A research method-initial measure/reference before intervention/treatment	
III. Other less frequent usage of the term 'line' (10)		
e.g.17 'The peritoneum is a filmy membrane, which **lines** the abdomen…'	-Referring to something covering the abdomen	Literal
e.g.,18 '…their disadvantaged profile with 100% judged below the **poverty line**…'	-Socioeconomic threshold for poverty	Metaphor

Fig. 1. The multiple meanings of 'line(s)' in ONCO Corpus

As illustrated in Figure 1, the multiple meanings of 'line(s)' are often extended figuratively. When 'line(s)'is utilized as a specialized term within the nursing context (Category I in Figure 1 below), it mainly conveys three kinds of information. Firstly, it provides general information about the professional roles of nurses (Examples 1 and 2). Secondly, the term delineates two major duties of nurses in clinical practice, that is, administering intravenous therapy (Example 3) through catheter lines (Examples 4-7), and providing guidance and advice through verbal communication (Examples 8-11).

It is worth noting that Examples 8-11 reveal the importance of specific multi-word units, commonly known as idiomatic expressions, as valuable nursing-specific linguistic resources that support appropriate and effective verbal communication within the nursing context. This skill is essential for providing information, offering advice, and building rapport with both medical professionals and patients. For instance, the phrase 'stay on the *line*' (Example 9), a common general English phrase, illustrates a 'metaphor from metonymy' [14], where the word 'line' metonymically refers to the telephone line which is then metaphorically extended to represent nurse-patient spoken communication. This reveals that the telephone line is conceptualized as a prototype and metaphorically adapted to describe the provision of non-face-to-face guidance and counselling services by nurses. Other examples demonstrating the importance of general English phrases or idiomatic expressions as valuable linguistic resources within the nursing context are 'came to the finishing *line*' (Example 10) and 'when *the line* would be drawn' (Example 11). These general English phrases become effective vague language or euphemism to

indirectly signal that a cancer patient is nearing the end of life, and that the cessation of treatment is imminent. Overall, the transformation of these 'line'-related general English phrases or idiomatic expressions as nursing-specific linguistic resources, help facilitate effective verbal communication that is both truthful and compassionate, making it more acceptable to patients and their families.
Additionally, the term also functions as part of an academic term employed in discussions pertaining to nursing research (Category II). Examples include 'line-by-line' (Example 13) and 'a base-line' questionnaire' (Example 16), which are frequently observed in the oncology research articles analyzed for this study. it can also be seen that the term 'line(s)' is occasionally employed to describe special situations within the nursing context (Category III, Examples 17 & 18).
To summarize, the multiple meanings of the polysemous term 'line' demonstrate how certain general English words are adapted into polysemous nursing-specific terminology via figurative extensions. These multiple meanings can be interpreted both literally and metaphorically to conceptualize various aspects of nursing practice. Furthermore, they underscore the significant role of specific general English phrases or idiomatic expressions in evolving into useful nursing-specific linguistic resources, thereby facilitating effective as well as compassionate verbal communication in the field.

4.2 The Survey

In the summer term of 2020, a survey was conducted with ninety L2 nursing students at a university in Hong Kong, with Cantonese as their native language. The survey was administered while the students were completing the final term of their first year of study. They were given eight extracts selected from the ONCO Corpus (See Appendix A for the extracts). All these extracts contain the polysemous item 'line(s)' as an individual word or as part of a phrase introduced in Figure 1. Figure 2 below shows the eight phrases with their meanings and their figurative mappings (if any) in the extracts. As shown in Figure 2 below, the meaning of 'line(s)' is figuratively extended in all cases except Extract 7. Overall, these eight 'line' phrases were selected from Category I in Figure 1 above, delineating the professional roles of nurses and two of their major responsibilities introduced in Section 4.1. Participants were invited to explain, in either English or Cantonese, the meanings of the term.
The survey, which focused on their interpretation of the polysemous term 'line(s)' in nursing contexts, sought to explore the potential challenges faced by L2 nursing students in Hong Kong when interpreting meanings of polysemous terms, which are predominantly influenced by metaphor and metonymy within the discipline-specific context of nursing.

Extract	Line-related phrases	Metaphor/literal	Mapping
1	'came to **the finishing line**'	Race metaphor	The finish line in a running race is mapped onto the concept of the end of life.
2	'**front line** health professional'	Military/battle metaphor	The foremost position in a battle is mapped onto direct-contact healthcare roles
3	'open the **lines** of communication'	Conduit metaphor	Messages are metaphorically mapped as flowing through channels or pipes.
4	'when **the line** would be drawn'	Boundary metaphor	The act of drawing a physical boundary line to separate spaces is mapped onto the process of making a decision, i.e., determining the time to stop treatment.
5	'who do not work **consistent lines**'	Organization as a 'line' metaphor	Team alignment or structural arrangement is metaphorically mapped onto a physical line.
6	'receiving **many lines** of treatments'	Pathway metaphor	Multiple routes/ courses of treatments are mapped onto different pathways.
7	'the retrograde back up of stagnate blood clot into **lines**'	Literally referring to catheter (the tubes)	Literally referring to the catheter lines for treatment.
8	'stay on **the line**'	Metaphor from metonymy (part-for-whole)	Staying on a telephone line stands for the whole verbal communication system,

Fig. 2. The eight phrases of 'line(s)' and their meanings in Extracts 1-8

4.3 Participants' Performance in Interpreting the Meanings of 'Line(S)'

Overall, their performance was categorized into seven major groups based on a classification framework adapted from [15] (see Figure 3 below). The participants' interpretations of the eight 'line-related' phrases were independently evaluated by two researchers using this framework. Any discrepancies in their assessments were resolved through discussion. Major interpretative challenges observed from these participants of the polysemous item 'line(s)' are discussed in subsections i to v.

Categorization	Description
Type Y	Correct interpretation of the figurative mapping of the term 'line(s)'
Type A error	No attempt at all
Type B error	Difficult to evaluate the provided interpretation, for example, the interpretation is off topic, not related to the meaning of 'line(s)', or incomplete.
Type C error	Difficult to evaluate as only direct Chinese translation of 'line(s)' is provided
Type D error	Provided overall correct meaning of the extract but ignored the meaning of 'line(s)' in their interpretation
Type E error	Wrong interpretation: provide a wrong or unclear literal meaning
Type F error	Wrong interpretation: provide a wrong or unclear metaphorical meaning

Fig. 3. Classification of participants' interpretation of line(s)

i. Insufficient readiness in interpreting 'line' as a general yet figurative nursing-specific term

Figure 4 below illustrates the overall performance of these students in interpreting the term 'line(s)' across the eight extracts provided. As illustrated in Figure 4, Row 1, the majority of participants successfully interpreted the meanings of the 'line'-related phrases in Extracts 1 and 6, achieving accuracy rates exceeding 65%. The accuracy rates for Extracts 2-3 were also relatively satisfactory, at around 50%. However, participants encountered greater difficulties in interpreting the 'line'-related phrases in Extracts 4, 5, 7 and 8, with accuracy rates ranging from 12% to 24 %. Notably, in three of these four extracts (excluding Extract 7), the polysemous term 'line(s)' is embedded within various multi-word idiomatic expressions. The low accuracy rates for these extracts suggest that these multi-word idiomatic expressions may not be in common use among Hong Kong Cantonese speakers, despite their frequent use in the English language. Another possible reason for their low accuracy rates is that participants may assume subject-specific knowledge is typically conveyed through complex vocabulary. As a result, encountering colloquial, everyday general English expressions in nursing texts may have conflicted with their expectations.

In the case of the literal interpretation of the term 'line' in Extract 7, approximately one-fifth of the participants (23%) correctly identified its literal meaning as referring to the physical instrument, 'catheter'. However, a significant proportion of participants misinterpreted the literal meaning of 'lines' in this Extract, associating it with 'blood vessel' or 'blood capillaries'. Additionally, one participant mistook its meaning as metaphorical, associating it with 'lines of *members*' (Appendix H, Responses 79). This confusion highlights a challenge that L2 students may face in understanding nursing-specific polysemous terms, whose meanings can shift between literal and metaphorical contexts. Overall, findings in Row 1 suggest that general English words, such as 'line(s)', may not be as readily understood by L2 learners as anticipated when these words take on discipline-specific meanings, particularly when they appear as part of everyday general English idiomatic expressions. Learners may disregard seemingly simple general English words in a text, thereby hindering their ability to grasp nuanced nursing knowledge embedded within them.

	Type	Extract 1 Appendix B	Extract 2 Appendix C	Extract 3 Appendix D	Extract 4 Appendix E	Extract 5 Appendix F	Extract 6 Appendix G	Extract 7 Appendix H	Extract 8 Appendix I
1	Y	66%	43%	49%	**20%**	**24%**	75%	**23%**	**12%**
2	D	2%	12%	8%	4%	1%	0%	5%	31%
3	A	15%	15%	14%	16%	17%	17%	18%	19%
4	B	9%	10%	26%	22%	29%	7%	28%	13%
5	C	3%	15%	0%	2%	1%	0%	2%	0%
6	E	3%	1%	2%	28%	12%	1%	23%	18%
7	F	2%	4%	1%	8%	16%	0%	1%	7%

Fig. 4. Overall performance of the students' interpretation of the term 'line(s)'

ii. Underinterpretation of nuanced knowledge in the figurative mappings of certain universal metaphors

In the first place, the comparatively higher accuracy rates in interpreting the extended figurative meanings of 'line(s)' in Extracts 1, 2, 3 and 6, that is, 'I came to the fishing line', 'front line professionals', 'open lines of communication', and 'receiving many lines of treatment' (Figure 4, Row 1) suggest that universal metaphors - such as race, battle, conduit, and pathway observed in these Extracts - are more accessible to individuals from diverse cultural backgrounds, including the L2 Hong Kong nursing students who participated in this study. Nevertheless, the insufficient elaboration provided by them in interpreting 'many lines' in the phrase 'receiving many lines of treatments' (Extract 6) indicates the importance of understanding the detailed metaphorical mappings between source and target domains when universal metaphors are utilized to convey nursing knowledge, to ensure nuanced comprehension. In this metaphor, the term 'lines' is conceptualized as distinct courses to medical care. Most students correctly interpreted the general meaning of 'many lines of treatments' to mean that the patients described in the extract received various kinds or courses of treatments. However, only a few succeeded in further elaborating on its more nuanced meaning. While it is accurate to interpret 'many lines' (source domain) in the phrase 'many lines of treatments' as generally referring to 'various types or courses (target domain) of treatments', the pathway metaphor more precisely suggests that just as distinct routes or pathways lead to different processes and outcomes (a detailed mapping within the target domain, the pathway metaphor), different courses are carefully tailored to the unique trajectories of different patients' recovery or illnesses. Developing an awareness of such nuanced metaphorical mappings is essential for nursing students to deliver nuanced, precise, and context-sensitive nursing care.

iii. Cultural variations in interpreting figurative meanings

Interestingly, many participants employed the bridge metaphor to explain their understanding of 'open the lines of communication' (Extract C). For instance, a participant explained 'open the lines of communication' as 'the connect, the *bridge* of communication from person to person' (Appendix D, Response 19) while another participant interpreted the phrase as 'the nurses are *bridges* between the patient and their family or relatives' (Appendix D, Response 57).

Firstly, this demonstrates that metaphor is an essential tool that human beings employed to express their ideas or conceptualize their thoughts on different domains. That is to say, metaphor is also the language that nurses live by for workplace communication [12]. Secondly, their use of the bridge metaphor in explaining the metaphorical meaning of 'open lines of communication' also draws our attention to cross-cultural variation in metaphorical conceptualization of nursing knowledge. The bridge metaphor utilised by the L2 Hong Kong Chinese students in this study while interpreting the phrase 'open lines of communication', is a 'spatial metaphor', suggesting their emphasis on 'connection and relationship'. However, this phrase in English is a channel (or conduit) metaphor, focusing on 'flow and transmission of information', which may reflect a more functional and mechanistic view of communication in English-speaking cultures [11].

iv. Misinterpretation of general yet essential nursing-relevant figurative idiomatic expressions

The low accuracy rates observed in interpreting Extracts 4 and 8 (Figure 4, Row 1, 20% and 12% respectively) highlight participants' limited awareness and understanding of general English figurative idiomatic expressions as essential linguistic resources in nurses' workplace communication. For instance, when interpreting the general English phrase 'stay on line' (Extract 8), where 'line' typically refers to telephone line or the internet, some participants misinterpreted 'line' as 'job position' and the entire phrase to mean 'staying in their job position' (Appendix I, Response 3). While this interpretation does not hinder nurses' understanding of their responsibility to provide guidance and information to patients and family, it suggests a lack of knowledge about the common idiomatic expressions they can use to facilitate workplace communication, particularly building rapport and showing care with patients. Another example revealing participants' insufficient awareness and understanding of general English idiomatic expressions is evident in their interpretation of 'line' in 'I came to the finishing line' (Extract 1). While 'the finishing line' is a widely recognized metaphor referring to the endpoint of a race – and life is often metaphorized as a race - some participants misinterpreted it as the end point of a personal goal in life, rather than the conclusion of life's challenges. For instance, a participant misinterpreted 'the finishing line' as 'the goal that I wanna achieve in life and I have tried my best' (Appendix B, Response 11) while two others misinterpreted it as 'their work or target' (Appendix B, Responses 86 and 87). These examples emphasize the need for developing greater familiarity with figurative English idiomatic expressions to enhance nurses' communication skills in nursing professional contexts.

v. Potential ambiguity arising from L1 interpretation

Finally, it is observed that some participants merely provided Chinese translation equivalents to the English 'line'-related phrases they were required to explain. For example, some participants provided the Chinese translation equivalent, '前線' (*qián xiàn*) while interpreting the meaning of 'front line health professional' (Extract 2). While '前線' (*qián xiàn*) is a typical Chinese translation employed to explain the

meaning of 'front line', it is uncertain whether the participants were aware of the nuanced mapping embedded in this battle metaphor that 'nurses are the workers who take the lead in treating patients and whose work is dangerous', as accurately elaborated by a participant (Appendix C, Response 59). Another example illustrating this uncertainty is in the participants' interpretations for Extract 4, 'when the line would be drawn'. While some of them accurately explained the phrase as 'deciding on when it is the exact time that treatments can be stopped (see examples in Appendix E, Responses 74, 78 and 88), some students explained the phrase as '劃界'*(huà jiè)* , which is the Chinese translation equivalent of the phrase 'the line would be drawn' (Appendix, E, Responses 63 and 76). In sum, the above Chinese translation equivalents provided by the participants leave us a gap as to whether they understand the precise and elaborative meaning of the phrase in the context of these two extracts.

5. Discussion and Conclusion: Pedagogical Implications

In this paper, through examining the multiple meanings of the term 'line(s), the ways in which an ordinary English word can evolve into a nursing-specific polysemous term via metaphorical and / or metonymical extension have been explained. Based on the challenges discussed in Section 4.3, it is recommended that teachers can explicitly direct their students' attention to the literal and figurative meanings of these ordinary yet polysemous nursing-specific terms. It may also be helpful to first introduce universal metaphors, such as the pathway and conduit metaphors, which are commonly employed to conceptualize nursing knowledge and are more accessible across different cultures. It is essential to emphasize their nuanced source-target mappings to foster a more precise understanding of the complex and nuanced nursing knowledge embedded within them. Additionally, teachers should be aware of cultural variations embedded in metaphorical conceptualization, as explained in the use of the bridge metaphor by the participants to explain the meaning of 'open lines of communication'. Awareness of cultural variation helps teachers understand the focus of the nursing knowledge delivered through different metaphors and assess how students direct their attention when using different metaphors to interpret and understand the figurative extensions of English nursing polysemous terms. Finally, the findings also highlight students' use of their L1 in articulating their understanding of nursing knowledge. Teachers should be cautious of the false assumption that the L1 translation equivalents y their students provided when explaining nursing terms necessarily indicate an accurate and nuanced understanding of the nursing knowledge conveyed in English nursing texts. Likewise, teachers should be mindful of the potential risk of overlooking the teaching of nuanced nursing knowledge when relying on L1 translation to explain nursing knowledge.
In sum, the strategies aim to improve the teaching and learning of figurative nursing-specific polysemous terms, thereby enhancing professional expertise, health-care provision, and patient safety.

APPENDICES

The survey (Appendix A) and the survey results (Appendices B-I) can be found from the Mendeley data repository (DOI: 10.17632/hbjm3wpxts.1).

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Intercultural Competence in Nursing Education: Integrating Theory, Practice, and Didactics in Higher Education

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Abstract

The increasing cultural diversity of European healthcare systems means nurses need to develop competencies that go beyond clinical expertise. This article examines the relevance of intercultural competence in nursing practice and education. Using theoretical approaches such as Campinha-Bacote's Process Model of Cultural Competence as a basis, the paper analyses three case studies addressing intimate care and gender roles, family involvement in decision-making, and culturally shaped understandings of pain and medication adherence. The analysis reveals that intercultural competence encompasses cognitive knowledge, reflective awareness, empathy, communication skills, and the capacity to negotiate culturally sensitive solutions within institutional constraints. The article also discusses implications for the didactic approach in higher nursing education, emphasising case-based learning, reflective practice, simulation-based training and the systematic integration of intercultural learning into curricula. It concludes that intercultural competence should be considered a cross-cutting professional competence, developed throughout nursing curricula rather than as an isolated teaching topic. The findings emphasise the necessity of providing structured learning opportunities, employing qualified educators, and implementing valid assessment methods to prepare future nurses to deliver culturally sensitive, patient-centred care in an increasingly diverse healthcare landscape.

Keywords: *Intercultural competence, Nursing education, Cultural diversity in healthcare*

1. Introdution

The increasing cultural diversity in European healthcare systems presents nursing professionals with complex demands that go beyond purely clinical expertise. Migration, demographic change, and globalization mean that patients with different cultural backgrounds, value systems, and concepts of health encounter one another in healthcare settings. This diversity affects not only communication processes, but also expectations of nursing care, decision-making, and approaches to illness and therapy [1]. For nursing professionals, this means that they must be able to recognize culturally shaped needs and respond to them appropriately. Intercultural competence is therefore increasingly understood as a key qualification in professional nursing. In addition to communication skills, it includes reflection on one's own cultural influences as well as the ability to adapt nursing practice in a context-sensitive manner [2]. Despite the high relevance of intercultural competence, nursing education often shows insufficient systematic integration of corresponding content into curricula [3]. Teaching offerings often remain selective and are not sufficiently linked to practical experience. This creates the need to develop didactic concepts that convey theoretical foundations while also promoting their application in realistic situations [4].

Against this background, the present paper pursues three objectives: First, the significance of intercultural competence for nursing practice is examined using concrete case examples. Second, these cases are analyzed with reference to established theoretical models of interculturality. Third, didactic approaches are discussed that enable the sustainable integration of intercultural learning into university-based nursing education.

2. Theoretical Background

Various theoretical models exist for the conceptual classification of intercultural competence, describing different dimensions of cultural sensitivity and practical competence. The following section presents selected approaches that are particularly suitable for analyzing nursing interaction situations.

2.1 Intercultural Competences in Nursing

In the health sciences discourse, intercultural competence is understood as a multidimensional construct that comprises cognitive, affective, and action-related components [5]. It describes the ability of nursing professionals to act effectively and appropriately in intercultural situations. In addition to knowledge about cultural differences, intercultural competence particularly includes reflection on one's own values and the ability to adapt nursing interventions to different cultural contexts [6].
In nursing science, intercultural competence is often linked to the concept of cultural competence, which aims at patient-centered and culturally sensitive care. The focus is not on attributing static cultural characteristics, but rather on a dynamic understanding of culture as situationally and individually shaped [4]. In nursing, intercultural competence is understood as the ability to act reflectively, appropriately to the situation, and with consideration of patient-specific needs in intercultural care situations [7].

2.2 Models of Intercultural Competence Development

To further conceptualize intercultural competence in nursing, various developmental models can be used that focus on learning and professionalization processes. One internationally widely received model is Campinha-Bacote's "Process of Cultural Competence in the Delivery of Healthcare Services," which describes cultural competence as a dynamic and never fully completed process. The model comprises the dimensions of cultural awareness, cultural knowledge, cultural skill, cultural encounters, and cultural desire, thereby emphasizing that both conscious self-reflection and repeated intercultural encounters are central prerequisites for competent action. From a nursing education perspective, this implies creating learning opportunities in which students can question their own assumptions, build knowledge about diversity, and test concrete action strategies in protected settings [8].
In addition to process-oriented models, approaches to cultural sensitivity and transcultural competence play an important role. These distinguish between ethnorelative and ethnocentric orientations and thereby describe developmental stages of intercultural attitudes. Nursing literature also emphasizes that intercultural competence is always embedded in institutional frameworks and organizational cultures and therefore must not be understood solely as an individual characteristic of nursing staff [6]; [7]. For university-based nursing education, this has two consequences: First, curricula should provide progressive learning opportunities along these developmental dimensions; second, opportunities for realistic, practice-oriented experience are essential in order to support the transition from cognitive knowledge to situational, action-related ability [4]; [3].

3. Analysis of the Case Examples in Relation to the Theoretical Framework

The following case vignettes are now analyzed with regard to the theoretical concepts of intercultural competence explained above. The aim is to systematically identify the demands on nursing action that become visible in these situations and to relate them to the dimensions of cultural competence, particularly cultural awareness, cultural knowledge, and cultural skill. On this basis, concrete reflection and learning potentials for university-based nursing education are subsequently derived. The analysis is carried out exemplarily using the first case vignette and can be applied analogously to the other cases.

Case 1 – Linguistic and Cultural Barriers in Intimate Care
On a surgical ward in an acute hospital, a female patient is on the second postoperative day following a lobectomy. The nursing care plan provides for her to be supported with personal hygiene and mobilized that morning in order to prevent postoperative complications. Due to the staffing situation, however, only a male nurse is on duty on the relevant side of the ward, while several patients requiring extensive and time-intensive care need to be attended to on the opposite side. The patient, who has a Muslim background, firmly refuses support with personal hygiene from the male nurse and justifies this with religious and cultural ideas of intimacy and gender roles. The male nurse faces the challenge of reconciling the nursing requirements of postoperative care with the patient's culturally and religiously grounded wishes, as well as with the organizational conditions.

Case 2 – Family Involvement and Decision-Making in Nursing Care
On an oncology ward, an older male patient is being cared for after chemotherapy. The treating physician plans an informational discussion about the further course of therapy and possible palliative options, since the previous treatment has not achieved the hoped-for success. The responsible nurse prepares the conversation and asks the patient whether he has any questions in advance or whether

she can organize anything for him. The patient responds hesitantly and asks for his entire family (his wife, adult children, and a brother-in-law) to be present during the discussion. He also expresses the wish that important decisions be made jointly with the family and not by him alone. The nurse is unsettled, as she assumes a patient-centered model in which the patient himself is at the center as the autonomous decision-making authority. She faces the challenge of reconciling the culturally shaped expectation of collective decision-making and family involvement with the principles of informed consent and individual autonomy, without disregarding the patient's needs or excluding the family.

Case 3 – Understanding of Pain and Adherence to Medication Intake
In a geriatric care facility, a resident with chronic back pain is being cared for. Despite a physician's prescription for regular pain medication, the resident frequently refuses to take it and states that pain "is part of life" and that one "has to endure it." In conversations, it becomes clear that the resident comes from a cultural environment in which expressing pain is considered a sign of weakness and in which taking strong medication is viewed with mistrust. The nurse observes that the resident is becoming increasingly immobile and is avoiding social activities, which indicates insufficiently treated pain. The nurse faces the task of building a trusting relationship, understanding culturally shaped ideas about pain and medication, and working together with the resident to find ways that both respect her values and enable appropriate pain therapy. In doing so, the nurse must navigate between the duty of nursing care, respect for autonomy, and consideration of culturally shaped patterns of interpretation.

3.1 Identified Competence Requirements

The three case vignettes presented illustrate that intercultural competence in nursing practice must be understood as a complex interplay of knowledge, attitude, and ability to act. At the cognitive level, all three situations require an understanding of culturally and religiously shaped ideas that significantly influence health behavior and interaction. In the first case, nursing professionals must recognize concepts of intimacy, gender roles, and professional distance as relevant influencing factors instead of interpreting them merely as "special requests." In the second case, knowledge of different concepts of autonomy and collective decision-making is necessary in order to understand family involvement not as a restriction of patient autonomy, but as a culturally embedded form of self-determination. The third case shows that culturally shaped concepts of pain and ideas about medication can influence adherence and that nursing professionals must be aware of these interpretive patterns and incorporate them into their care planning.
At the reflective and affective level, the ability for self-reflection and empathy becomes particularly evident in all three cases. Nursing professionals are required to critically question their own ideas of efficiency, professionalism, autonomy, and pain management and not to judge prematurely why patients reject certain offers or express different expectations. This also includes recognizing power asymmetries in the nursing situation: patients are in vulnerable positions, while nursing professionals possess institutional interpretive authority as well as temporal and organizational resources. Intercultural competence is shown here in the willingness to adopt the perspectives of patients and relatives and to take their reasons seriously, without negating one's own nursing responsibilities. This reflective attitude is particularly relevant in the second case, where Western-influenced concepts of individual autonomy come into tension with collective decision-making models, as well as in the third case, where the duty of care and respect for culturally shaped coping strategies must be balanced.
At the action-related level, several concrete competence requirements can be identified. These include the ability to shape negotiation processes with patients and relatives in which nursing requirements and cultural or religious needs are made transparent and shared solutions are developed. In the first case, this may mean actively shaping organizational conditions and seeking interprofessional or team-based support, for example through reorganizing task distribution or making temporal adjustments. In the second case, this requires communicative competence in order to involve the family without overriding the patient's voice, as well as the ability to sensitize the interdisciplinary team — for example physicians and social workers — to culturally sensitive discussion formats. In the third case, nursing professionals must be able to develop alternative approaches to pain therapy that take culturally shaped reservations into account, for example through gradual education, involvement of trusted persons, or adjustment of the form of administration. The case vignettes thus demonstrate exemplarily that intercultural competence includes both individual and organizational dimensions of action.

3.2 Reflection and Learning Potentials for Students

For university-based nursing education, the three case vignettes offer diverse potential for stimulating reflection processes among students and specifically promoting the development of intercultural competence. At a first level, students can be invited to view the situations from different perspectives: from the perspective of the patients, the relatives, the nursing professionals, and the organization. Such perspective-taking supports the development of empathy and helps to relativize premature judgments — such as “the patient is uncooperative,” “the family is interfering,” or “the resident is non-compliant” — in favor of a more differentiated understanding of reasons for action and contextual conditions. In guided reflection sessions, students can also address their own reactions, irritations, or defensive attitudes and thereby contribute to the development of cultural awareness.
Furthermore, the cases are suitable for integrating theoretical models of intercultural competence development into didactic work. Students can, for example, systematically work through the process of managing the situation using models such as the process of cultural competence — for example cultural awareness, knowledge, skill, encounters, and desire — and examine which dimensions are particularly required in the respective case constellations. In the first case, cultural awareness, meaning self-reflection on one’s own norms, is central; in the second case, cultural knowledge, meaning understanding collective decision-making models; and in the third case, cultural skill, meaning communicative negotiation in the context of adherence problems. In this way, theoretical knowledge is not treated abstractly, but is concretely linked to realistic nursing situations. At the same time, it is possible to discuss which additional competences — for example in the area of organizational negotiation or interprofessional collaboration — have so far been insufficiently represented in classic competence models.
Finally, the vignettes open up possibilities for action-oriented forms of learning, for example through role plays, simulation-based scenarios, or case-based discussions. Students can try out different communication strategies, develop alternative solutions, and reflect together on their effects. Through feedback from teachers and peers, they can experience how word choice, nonverbal communication, timing, and the way nursing measures are justified affect trust and willingness to cooperate. This makes clear that intercultural competence does not arise solely through cognitive learning, but above all through repeated, guided practice and reflection in complex, ambiguous situations. Such learning arrangements lay the foundation for students to later be able not only to theoretically justify culturally sensitive decisions in their professional practice, but also to implement them responsibly in practice.

4. Didactic Implications for Nursing Education

The analysis of the three case vignettes has shown that intercultural competence in nursing comprises cognitive, reflective, and action-related dimensions that must not be developed in isolation from one another, but rather integrated into complex practical situations. This results in concrete requirements for the design of university-based nursing education. The following section discusses three central didactic approaches that enable the systematic and practice-oriented integration of intercultural learning into curricula: case-based learning and reflective practice, simulation-based learning formats, and intercultural training modules and their curricular anchoring.

4.1 Case-Based Learning and Reflective Practice

Case-based learning is particularly suitable for depicting the complexity of intercultural nursing situations and encouraging students to analytically engage with real problems. The case vignettes presented can be used in various teaching formats, such as seminar discussions, small-group work, or portfolio assignments. What is essential is that the cases are not presented as examples of “right” or “wrong” solutions, but rather as starting points for differentiated engagement with competing values, institutional conditions, and professional scope for action. Students can be guided to adopt different perspectives, develop alternative courses of action, and evaluate them with regard to nursing, ethical, and cultural dimensions. Current reviews show that case-based learning contributes to competence development particularly when it is linked to guided reflection phases in which students can address their own assumptions, uncertainties, and affective reactions [4],[2].
A central element of reflective practice is the systematic promotion of cultural awareness, that is, conscious engagement with one’s own cultural influences, normative assumptions, and positions of power [8]; [6]. This can be supported through structured reflection tasks, such as keeping learning journals, guided self-reflection exercises, or peer-feedback formats. Teachers should create a protected

space in which students may also articulate irritations, uncertainties, or internal resistance without having to fear being judged as “intolerant.” Especially the confrontation with one’s own blind spots and assumptions is an essential component of intercultural learning processes and can be specifically initiated through case-based work (Dimitrova & Sehouli, 2023; [6].

4.2 Simulation-Based Learning Formats

In addition to case-based discussion formats, simulation-based learning environments offer the opportunity to experience and practice intercultural nursing situations in an action-oriented way. In role plays or with simulated patients, students can reenact the situations described in the case vignettes and try out different communication strategies, forms of argumentation, and nonverbal behaviors. Within the protected framework of simulation, students can make mistakes, experience uncertainty, and learn from these experiences without real patients being affected. International studies show that simulation-based training can contribute to the development of cultural competence, particularly when it is combined with structured debriefing phases in which the experience is jointly reflected upon and theoretically contextualized [4].
Concrete simulation scenarios can be developed for the three case vignettes presented. In the first case, concerning intimate care and gender roles, students can practice how to conduct a respectful conversation with the patient within a limited timeframe, negotiate organizational solutions, and at the same time make nursing necessities transparent. In the second case, concerning family involvement and decision-making, it can be simulated how an informational discussion can be structured in a way that both recognizes the patient as an autonomous subject and involves the family without perceiving their presence as a “disruption.” In the third case, concerning understanding of pain and adherence, students can practice how to build a trusting relationship, address culturally shaped reservations, and develop viable compromises together with the resident. Such simulations make it possible to specifically train cultural skill, that is, the concrete application of intercultural competences in interaction, and to deepen it through repetition and variation [2];[8].

4.3 Intercultural Training Modules and Curricular Anchoring

In addition to selective teaching and learning arrangements, systematic curricular anchoring of intercultural competences is necessary in order to achieve sustainable learning effects. This means that intercultural content should not be addressed only in individual elective modules or projects, but must be integrated as a cross-cutting theme in various modules and across several years of study [3]; [4]. The integration of cultural competence into nursing education can take different forms: through the design of independent cultural competence courses, through the embedding of cultural content into existing theoretical and clinical courses, or through the continuous consideration of cultural diversity in all learning opportunities. Studies show that continuous development of cultural competence throughout the entire nursing program, both in theory and practice, is more effective than isolated individual measures [4].
A particular challenge lies in the assessment and evaluation of intercultural competence development. While cognitive knowledge can be assessed through traditional examination formats, reflective and action-related dimensions are more difficult to measure. Regular assessment of students’ competence development is considered necessary in order to monitor learning progress. Alternative examination formats such as OSCEs — Objective Structured Clinical Examinations — with standardized patients can be used for this purpose, enabling feedback on professionalism, communication skills, and culturally sensitive behavior [4].
Moreover, the qualification and continuing education of university lecturers themselves is a central prerequisite for successful cultural education [9]; [10]; [3]. Lecturers should possess intercultural competences and receive continuous training in culturally and linguistically appropriate care [4]; [9]. Studies show that lecturers with international education, multilingual abilities, and participation in cultural training are better able to engage students in discussions about cultural diversity. The importance of age, multilingualism, and continuing education for the development of cultural competence among lecturers is emphasized by current research. Therefore, targeted interventions such as language support programs, cultural competence training, and the promotion of reflective practices should be implemented in order to improve the cultural competence and transcultural teaching behavior of nursing educators [9].
Finally, the involvement of external partners, such as intercultural trainers, self-organizations, or patient representatives, is valuable. Through guest lectures or joint workshops, students can gain insights into

different perspectives. Such participatory approaches help to avoid essentialist notions of culture and promote a dynamic, context-related understanding of diversity [3]; [4].

5. Discussion and Conclusion

In light of increasing social diversity, the development of intercultural competence in nursing education represents a central educational policy and professional challenge. The present analysis shows that a theoretically grounded understanding of culture and cultural competence, as offered by Campinha-Bacote's Process Model [8], is a necessary but not sufficient prerequisite for practice. Sustainable competence development can only succeed through the combination of theoretical grounding with evidence-based didactic strategies.

The examined teaching and learning strategies, such as case-based learning, simulation training with standardized patients, cultural immersion experiences, and curricular integration, prove effective when they build systematically upon one another and are implemented throughout the entire course of study [4]; [3]. Particular emphasis should be placed on the importance of reflective learning processes that enable students to recognize and critically question their own cultural influences [1]; [2]. Without this self-reflection, there is a risk that cultural knowledge leads to stereotypical attributions rather than to differentiated, context-sensitive nursing practice.

A central finding is that intercultural competence must not be understood as an additive curriculum element, but as a cross-cutting competence embedded in all modules. However, this also requires university lecturers themselves to possess the corresponding competences and to receive continuous professional development [9], [10]. The qualification of lecturers, particularly with regard to their cultural sensitivity, language competence, and didactic skills, is therefore an essential institutional task.

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Implications of Correlations between Communication Stressors and Correlations between Anxiety and Mental Health

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Abstract

During the periodic medical check-up, workers from one high school (having 93 employee) and 2 middle schools (with 43 and respectively 35 employee) received a voluntary questionnaire that included the following:
-socio-demographic variables (age, length of employment in the unit, biological gender, type of residence);
Six occupational stressors that scored the worker's stress (on a Likert-type scale) related to communication with colleagues, students and their parents: "Verbal violence from other employees", "Verbal violence from some students", "Verbal violence from some parents", "Physical violence from some parents", "Difficult cooperation with some parents", "Difficult cooperation with some students";
-the personality traits of Gray's Behavioral Inhibition and Activation Systems [BIS/BAS], namely anxiety, fun-seeking, drive, reward-responsiveness
- The General Health Questionnaire (12 item). This questionnaire in used as a screening instrument for mental health and psychological -psychiatric disorders in non clinical settings
In the 3 schools the level of stressors ranges from low to medium.
In all 3 schools there are positive correlations between occupational stressors as follows:
-"Verbal violence from other employees" correlates with "Verbal violence from some parents"(p1=0.001;p2=0.016;p3=0.009) and with "Physical violence from some parents"(p1=0.030 ;p2<0.001;p3=0.002);
-"Verbal violence from some parents" correlates with: "Difficult cooperation with some parents"(p1=0.001; p2=0.006;p3<0.001) and with "Difficult cooperation with some students"(p1=0.001;p2=0.016;p3=0.002);
"Verbal violence from some students" correlates with "Difficult cooperation with some students" (p1=0.001; p2=0.001; p3=0.017).
In all 3 schools, GHQ correlated with Anxiety (BIS) (p1<0.001; p2=0.044; p3=0.006).
Although the number of respondents is not large, the consistent results obtained in all 3 schools draw attention to the importance of the results obtained. Although the level of stressors related to communication problems with students and their parents is low, the data obtained lead to the conclusion that in schools, in the present and at least in the immediate future, the efficiency of student-teacher communication and in fact the success of the educational act requires the active involvement, at least from the point of view of facilitating communication, of parents.
Among school workers, although anxiety levels are not high, their association with mental health disorders shows the importance of informing workers about this issue and managing anxiety-generating situations.

Keywords: *Anxiety, mental health, school, communication stressors, students, parents*

Introduction

In the educational environment, communication is essential for the efficiency of the educational act. Good communication allows for relationships with others and even the establishment of interpersonal relationships, and the way in which teachers communicate with students modulates their behaviors and integration in the classroom and even socially, the advantages of effective communication being numerous.
For teachers, stressors related to communication are mainly represented by tense interactions with students (lack of receptivity, disinterest, disruptive attitude and indiscipline in the classroom, resistance to dialogue by students, emotional barriers of students), with parents (unrealistic expectations of parents, intrusion and criticism of teachers, insufficient involvement in home education, etc.), with

colleagues (gossip circles, uncollegial attitudes, unconstructive criticism, etc.) and with the management department (bureaucratic requirements, lack of institutional support, conflicts of ideas, authoritarian communication, ineffective meetings, etc.). Along with students, parents can influence the way they communicate with school staff.
If the teacher is stressed even by the inefficiency or deficiencies of communication with students, the stress can spread to the students and their behavior worsens, reflecting more stress on the teacher and can lead to a generalization of the stress level in the classroom. This vicious circle of stress related to student-teacher communication once it is started, becomes difficult to break.
Stress on school staff can be influenced by their personality traits. For example, it is known that the Behavioral Activation System (BAS) or the "start" system, activates approach motivation, regulates responses to pleasant stimuli, goal achievement and rewards. People with a high BAS show joy, enthusiasm, hope, are predominantly extraverted, impulsive, action-oriented. The Behavioral Inhibition System (BIS), also known as the "braking" or threat avoidance system, regulates the response to dangers, punishments, frustration, and is associated with anxiety, fear, and insecurity. Individuals with a high BIS are more sensitive to criticism and avoid risks [1].
In assessing workplace stressors, it is also important to assess the mental state, anxiety, and/or well-being of the individual. At the organizational level, questionnaires can be used that, in order not to burden the respondent's schedule or time, should be as easy or quick to complete as possible.

Material and Methods

During the periodic medical check-up, workers from one high school (having 93 employees) and 2 middle schools (with 34 and respectively 35 employees) received a voluntary questionnaire that included the following:
- socio-demographic variables (age, length of employment in the unit, biological gender, type of residence);
-six occupational stressors that scored the worker's stress (on a Likert-type scale in 3 steps, on a perceived level of stress scored from "very low"=1, to "medium"=2 and to "high"=3) related to communication with colleagues, students and their parents: "Verbal violence from other employees", "Verbal violence from some students", "Verbal violence from some parents", "Physical violence from some parents", "Difficult cooperation with some parents", "Difficult cooperation with some students";
- The General Health Questionnaire (GHQ12). having 12 items on a 4-point Likert scale is used as a screening instrument to detect mental health and psychological -psychiatric disorders and common psychological issues like anxiety, depression, and social dysfunction in non-clinical settings [2];
-the personality traits of Gray's Behavioral Inhibition and Activation Systems [BIS/BAS], namely anxiety, fun-seeking, drive, reward-responsiveness [3].
The present study aimed to evaluate the level of stressors in school workers related to communication with students, colleagues, and parents as well as the perceived level of negative reactions they have towards the workers (GHQ12) [4], in relation to the personality traits of the workers (BIS/BAS dimensions) and socio-demographic indicators [5], [6].

Results

The number of participants (respondents) completing the questionnaires is high in the 3 school units (Table 1).

Table 1. Number of workers and number of non-respondents by school unit

School unit	number of workers	number of non-respondents
School no 1	92	33
School no 2	33	3
School no 3	34	5

School no. 1 is located in an urban area and schools no. 2 and no. 3 are located in a rural area. The proportion of workers is similarly distributed by type of residence (Table 2).

Table 2. Percentage of female workers and those living in urban areas by school

	percentage of women	percentage of people living in urban areas
School no 1	68	82
School no 2	79	6
School no 3	79	4

Female workers predominate in all schools compared to males. In terms of age and length of employment in the school, workers in the 3 school units have an average age between 45 and 48 years and an average length of employment in the unit between 12 and 17 years (Fig. 1.).

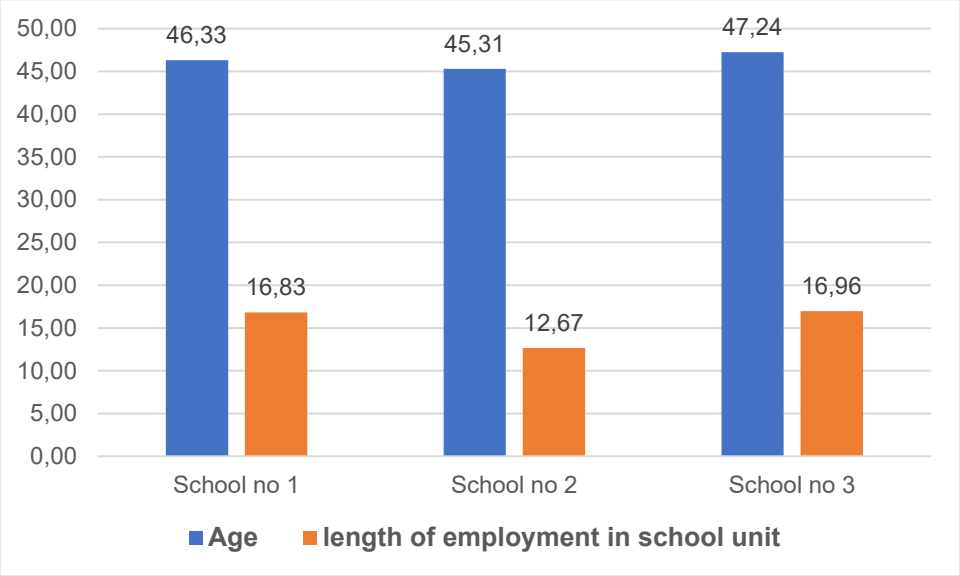


Fig. 1. Age and average duration as a worker in the unit after school

Middle adulthood or mature adulthood, between 40 and 65 years of age, indicates self-confidence, clear values, and reaching the peak of one's professional life. An optimal duration for an individual to have good professional experience at a workplace is a minimum of 3 years. A longer duration shows professional experience on the part of the worker as stability, loyalty, and interest in the workplace and in the respective activity. In the 3 schools the level of stressors ranges from low to medium (Fig. 2.)

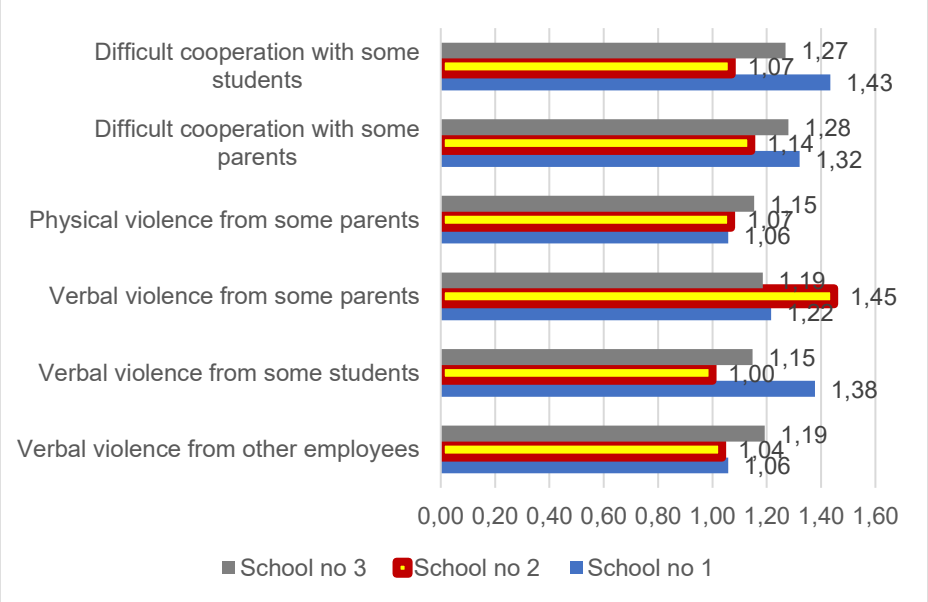


Fig. 2. Average level of stressors in workers by school

Average values of personality traits dimensions [BIS/BAS] in workers are similar in the 3 schools (Fig. 3.)

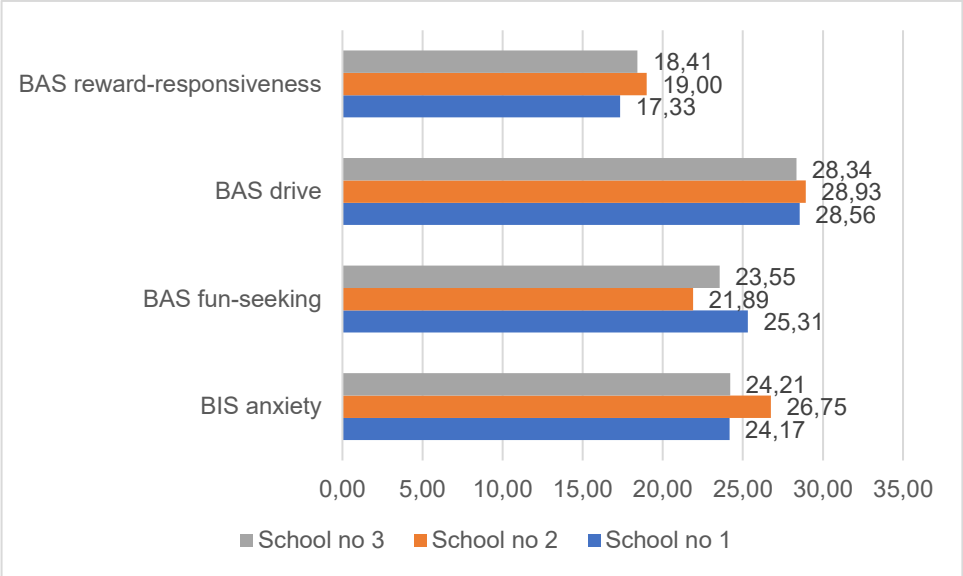


Fig. 3. Average values of personality traits dimensions [BIS/BAS] in workers depending on school

The distribution of respondents by school department is presented in Table 3. The main occupational group is represented by teachers. The non-teaching department includes cleaners, security guards, maintenance workers, and drivers, while the auxiliary department includes accountants, property administrators, financial administrators, librarians, secretaries, and IT network administrators.

Table 3. Distribution of respondents in the 3 schools by department

School unit / department	number of workers		
	auxiliary	(didactic) teaching	non-teaching
School no 1	2	55	2
School no 2	2	21	7
School no 3	3	19	7

Among the variables studied, there are significant differences between the values of the variables studied between workers in the 3 compartments, only those mentioned.
Thus, in School no.1, workers in the non-teaching compartment (p=0.018) have the highest average value (namely 2) of the stressor "Verbal violence from other employees" compared to workers in the auxiliary compartment (namely an average score of 1) who have the lowest value.
In School no.2, there are no significant differences between the variables studied depending on the school compartment.
In School no.3, workers in the non-teaching compartment have the highest (p=0.001) age (with an average of 56.29 years) compared to workers in the teaching compartment (with an average value of 43.68 years).
In the total group of respondents from the 3 schools, there are significant differences between the variables studied by department for 2 variables as follows:
-Age (p=0.034) workers in the non-teaching department have the oldest age (with an average of 52.71 years) compared to workers in the teaching department (with an average value of 45.26 years);
-"Verbal violence from some parents" has the highest value (p=0.011) among workers in the non-teaching department (with an average of 2.17) compared to workers in the auxiliary department who have the lowest value (average value of 1.17).
There are numerous correlations between the variables studied, different according to the school unit. However, similar correlations also appear in all 3 schools, which suggests a tendency to generalize these results.
In all 3 schools there are positive correlations between occupational stressors as follows:

-"Verbal violence from other employees" correlates with "Verbal violence from some parents"(p1=0.001;p2=0.016;p3=0.009) and with "Physical violence from some parents"(p1=0.030; p2<0.001; p3=0.002);
-"Verbal violence from some parents" correlates with: "Difficult cooperation with some parents"(p1=0.001; p2=0.006;p3<0.001) and with "Difficult cooperation with some students"(p1=0.001;p2=0.016;p3=0.002);
"Verbal violence from some students" correlates with "Difficult cooperation with some students" (p1=0.001; p2=0.001; p3=0.017).
In all 3 schools, GHQ correlated with Anxiety (BIS) (p1<0.001; p2=0.044; p3=0.006).

Conclusions

The levels of stressors related to communication between workers and students, parents of students and other employees are generally low and do not differ significantly between teachers and workers in other departments (auxiliary and non-teaching). Overall, workers in the non-teaching department have significantly higher stress levels compared to workers in other departments in Verbal violence from parents.
The perception of stress related to communication with other workers is associated with the perception of stress given that communication with parents (even with physical violence from them) is expected to be unrelated to personality traits of Gray's Behavioral Inhibition and Activation Systems [BIS/BAS].
Although the number of respondents is not large, the consistent results obtained in all 3 schools draw attention to the importance of the results obtained. Although the level of stressors related to communication problems with students and their parents is low, the data obtained lead to the conclusion that in schools, in the present and at least in the immediate future, the efficiency of student-teacher communication and in fact the success of the educational act requires the active involvement, at least from the point of view of facilitating communication, of parents.
Anxiety as a personality trait is associated with affecting the state of health (mental health and psychological -psychiatric disorders) without these being constantly associated with perceived stress as a result of communication difficulties with students, their parents and other employees.
Among school workers, although anxiety levels are not high, their association with mental health disorders shows the importance of informing workers about this issue and managing anxiety-generating situations.

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Smart Healthcare Engineering: An Innovative Educational Framework for Training Future Healthcare Engineers

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Abstract

The digitalization of healthcare systems and the increasing complexity of medical infrastructure require engineers capable of operating at the interface between engineering and healthcare. This study presents the Erasmus+ project Smart Healthcare Engineering (SHEng) that aims to create an educational framework that combines engineering, healthcare technologies, hospital management and practical training in real medical environments. The concept brings together universities and healthcare institutions from Romania, Spain and Türkiye to develop innovative learning resources, intensive international training program and an open e-learning platform dedicated to healthcare engineering [1]. The educational model integrates theoretical instruction, laboratory activities, hospital based case studies and collaborative international learning experiences. A key component of the project consisted of intensive training program organized in Spain and Romania, involving students from different academic and cultural backgrounds. The results showed clear improvements in students' knowledge and understanding of healthcare engineering topics, while also highlighting the positive impact of transnational and multidisciplinary learning environments on student engagement and performance. The study outcomes include innovative educational materials and a new methodology for competency based training in healthcare engineering. The results indicate that international collaborative learning, supported by digital educational tools and practical hospital exposure, is a good method for preparing future engineers to meet the technological challenges of healthcare.

Keywords: *Healthcare engineering, international training, healthcare management*

1. Introduction

The healthcare systems are changing very quickly and now hospitals are no longer only medical facilities where doctors and nurses provide care but are a complex technical environment that depends on medical devices and digital systems, water systems, ventilation systems and many other support services. In this context, engineering has a key role in healthcare and without well designed, maintained and safe technical systems, the medical care cannot be delivered at the required level of quality.
Healthcare engineering can be understood as the application of engineering knowledge, technical management and problem-solving methods to healthcare system, being closely connected with hospital engineering. The engineer that works in the hospital is the professional that can support decisions related to technology selection, safety, maintenance, risk reduction, regulatory compliance, user training and the integration of medical technologies into clinical workflows. Yadin D. [2] shows the major impact of clinical engineers and Health Technology (HT) on global patient outcomes. In many hospitals, engineering departments contribute directly to patient safety, cost control and the effective use of medical technologies.
The role of engineers in hospitals has become more visible because of the increasing number and complexity of medical devices. Imaging systems, monitoring equipment, ventilators, laboratory equipment and digital health platforms require permanent technical support [3]. These technologies must be selected, installed, calibrated, maintained and used correctly because a technical failure can affect diagnosis, treatment, patient safety or the continuity of medical services. For this reason, the hospital engineer must understand not only the technical characteristics of equipment, but also the clinical context in which the equipment is used.

At the same time, hospitals are under strong pressure to reduce energy consumption, optimize resources, improve patient flow, control infections, reduce risks and integrate digital solutions. These challenges cannot be solved only by medical staff. They require interdisciplinary teams, where engineers, doctors, nurses, managers and IT specialists work together. Studies in clinical engineering and healthcare technology management show that engineering professionals can have an important impact on the performance of healthcare systems, especially when their activity is connected with patient outcomes and hospital management [4].
Digital transformation is another important factor that changes the role of engineering in healthcare as uprising technologies are now part of healthcare facilities [6]. Artificial intelligence (AI) is now used in image processing and interpretation but also in data analysis from sensors spread in the hospital areas [8]. These technologies create new opportunities, but also new risks in terms of cybersecurity, data flow, equipment connectivity, user acceptance and the validation of digital health solutions [9,10].
The Digital health cannot be implemented only by buying technology but requires training, organizational change and technical support from specialized engineers.
A graduate who wants to work in healthcare engineering should understand medical technology, hospital infrastructure, safety, quality management, digital systems, sustainability and communication with healthcare professionals. This type of profile is not easy to develop through traditional engineering profile from EU Universities. The current engineering curricula are often organized by discipline, such as materials, mechanical engineering, electrical engineering or industrial engineering. However, the hospital environment is interdisciplinary by nature. The same technical problem can include aspects of mechanics, electronics, materials, software, standards, hygiene, ergonomics, maintenance and human behavior. For this reason, engineering education must create learning situations that are closer to the real conditions of healthcare practice. Students need to see hospitals not only as users of technology, but also as complex systems where engineering decisions have direct effects on medical activity. Experiential learning, project-based learning and workplace learning are useful approaches in this direction. They allow students to apply knowledge in real or realistic contexts, to work in teams, to solve open problems and to understand the connection between theory and practice [5].
Therefore, education must prepare students to communicate across professional boundaries. Interprofessional education has been widely discussed in health professions education, especially for improving collaboration and patient care [11-13]. Although engineering students are not always included in classical interprofessional healthcare training, their future role in hospitals makes such preparation important.
This study presents the concept of a project developed in this context. The project responds to the need for a new educational framework able to prepare engineering students for the technological and operational challenges of modern hospitals. It brings together universities and healthcare institutions from Romania, Spain and Türkiye and proposes an interdisciplinary model based on international collaboration, intensive training program, hospital visits, laboratory activities, e-learning resources and practical case studies [1].
The main idea of the study is that healthcare engineering cannot be taught only from books. The students need to understand that healthcare engineering is not limited to medical devices. It includes maintenance, quality, risk management, metrology, medical gases, corrosion, materials, energy efficiency, digital systems, occupational safety as well as many other technical aspects that support hospital activity.
The purpose of this paper is to present the educational methodology and implementation of the SHEng concept, with a focus on the activities developed during the intensive training program and on the general educational impact observed during the project.

2. Methodology

The educational methodology from this study was designed to combine theoretical learning, practical hands on demonstrations, hospital visits and international collaboration. The project was not built as a classical course, but as a learning ecosystem that includes intensive training programs, learning materials, and hospital case studies. The project consortium includes higher education institutions and healthcare organizations from Romania, Spain and Türkiye. This partnership is important because it connects the academic perspective with the practical needs of hospitals. Universities provide teaching expertise, research knowledge and student groups. Hospitals provide real examples, infrastructure, clinical context and professional experience. Figure 1 shows the main concept of the Smart Healthcare Engineering concept.

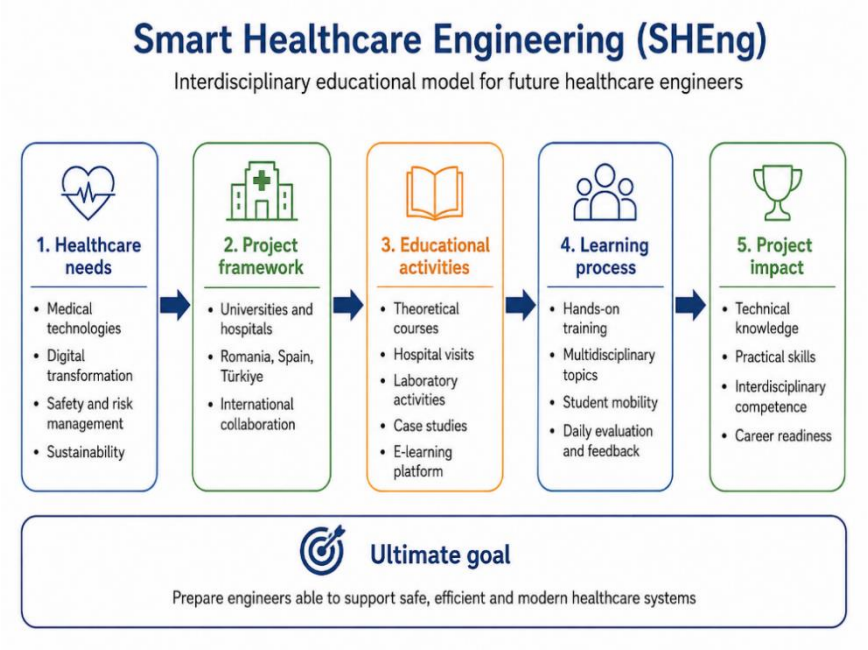


Fig. 1. Smart Healthcare Engineering educational concept

The Smart Healthcare Engineering concept is based on two different directions. One is the intercultural interaction between students and teachers and on the modern teaching activities organized as intensive training sessions. The main concept is based on organizing intensive training programs for small groups of international students from engineering fields and prepare them for a future career in the healthcare domain.

The training sessions were designed as international learning experiences, where students from different universities participated in lectures, practical sessions, laboratory work and hospital visits. The training program was not limited to a single discipline but included topics from healthcare engineering, medical technology, hospital infrastructure, materials, maintenance, quality, safety and digital systems.



Fig. 2. During the teaching session at Dr. Negrin Hospital, Las Palmas de Gran Canaria, Spain and at Transilvania University of Brașov, Brasov, Romania

The general structure of the intensive training programs included 12 daily teaching activities, technical presentations, practical demonstrations and evaluation activities before and after each teaching sessions. The topics were selected to show the broad role of engineering in hospitals, including hospital risk areas, protection of staff and patients, role of the healthcare engineer, medical equipment and machinery, metrology, communication between engineers and medical staff, corrosion in hospital installations, stainless steels used in healthcare, medical gases, oxygen pipelines, energy saving, Legionella prevention, SCADA systems, maintenance indicators, non-destructive testing and safety procedures.

A strong element of the methodology was the use of hospital based learning that helped students to connect abstract technical concepts with real hospital applications. For example, i) a topic such as corrosion becomes more relevant when students understand its effect on hospital installations, ii) a topic

such as maintenance becomes more concrete when students see how a failure can affect a medical service, iii) a topic such as medical gases becomes clearer when students see the pipeline route and understand the importance of oxygen supply for patient care.
The teaching activity also included case studies that have been built around equipment maintenance, hospital infrastructure, energy consumption, technical risk, safety incidents, medical gas systems, infection prevention or communication between departments. These case studies help students develop problem solving skills and understand that hospital problems are rarely simple because often involve organizational and human factors.
The teaching-learning methodology included student evaluation based on multiple-choices questionnaires and self-assessment tests used daily to monitor learning progress and student perception. The aim of the evaluation was to identify changes in student knowledge, engagement and understanding of healthcare engineering topics.
A key element was the adjusting of the course level each day based on the results of the evaluation made on the previous training day. In this way, the teachers knew what were the strong and week point in the students knowledge. This educational methodology and structure is aligned with current trends in engineering education, where students are expected to develop not only technical knowledge, but also transversal skills [14, 15]. In the SHEng concept, these methods were adapted to the specific field of healthcare engineering.

3. Results

The first important result of the project was to identifying the complexity of the healthcare engineering field and creation of an interdisciplinary educational framework for healthcare engineering.
This teaching - learning concept connects engineering education with real hospital needs by offering to students the possibility to understand how technical systems support medical activity and how engineering decisions can influence safety, efficiency and quality in hospitals. The project also helped clarify the professional role of the healthcare engineer as a link between technology, infrastructure, management and clinical practice.
A visible result after the training sessions was the increased awareness of students regarding the complexity of hospital infrastructure as many engineering students being familiar with industrial systems, but not fully understand the technical complexity of hospitals.

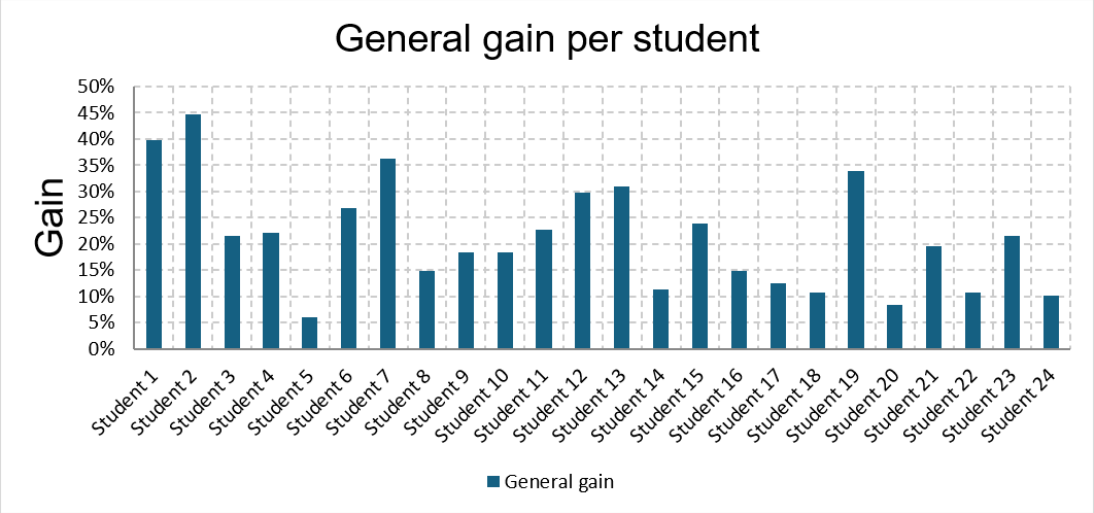


Fig. 3. General gain per student during the Smart Healthcare Engineering training activities.

Figure 3 presents the general learning gain obtained by each of 24 students after participation in the Smart Healthcare Engineering 12 days of training activities. The gain was calculated as the difference between the initial and final level of knowledge, expressed in percentage points, as follows:

$$Gain_i = Post\ i - Pre\ i \quad (1)$$

where:
$Post_i$= score of student *i* in **Test general after** the training

Pre_i= score of student *i* in **Test general before** the training

The results show a positive gain for all students, which indicates that the educational activities contributed to an improvement in the general understanding of healthcare engineering topics.
All students show positive general gain after the training activities, and most gains appear to be between 10 and 30 percentage points, with several higher values around 30% to 45%. At the same time, the graph of fig. 3 shows some variation between students. This variation is normal in an international training program, because participants had different academic backgrounds, previous knowledge, learning styles, levels of attendance and engagement during the activities. Students with lower gains should not automatically be interpreted as having poor performance, because a smaller gain may also be related to a higher initial score before the training.
The observed feedback from students and teachers indicated that the practical and international character of the project was appreciated. Students were interested in topics that connected engineering with real hospital problems. They also showed interest in understanding how medical technologies are used, maintained and managed and some students expressed an interest in following a career in healthcare engineering. This is important because many students do not initially associate their engineering education with healthcare.

4. Discussion

The SHEng project and educational concept confirm the importance of practical and interdisciplinary education in healthcare engineering. Modern hospitals require engineers who can understand both technical systems and healthcare needs. This type of professional cannot be prepared only through traditional lectures as the students must be exposed to real problems, real infrastructure and real communication situations. The project responds to this need by combining classroom learning with, hospital visits, hands-on activities and international collaboration.
One important aspect is the role of hospitals as learning environments. In many instances the hospital as learning environment is associated with residents, doctors and nurses that are involved in the medical act. Hospitals are sensitive institutions where patient safety, confidentiality, hygiene and clinical activity are priorities and the learning activities for the technical part of the facility often raise issues in affecting the daily medical work. The content of the classes must be organized in a clear way and on site visits should be spot on, so that students do not feel overwhelmed by the large amount of information.
The training sessions also had some limitations. The different academic background of the students was one of the main challenges. The participants came from different countries, universities and years of study. In this particular case, the students were from industrial engineering, materials science, electrical engineering and bioengineering and were enrolled in the first, second or third year of study. This diversity was useful for interdisciplinary learning, but it also required the teachers to adapt the level and rhythm of the courses. Another challenge was the English language. Even if the students had a good level of English, the specific terminology used in healthcare engineering created some difficulties during the learning process. This issue was addressed by providing explanations in simpler terms and when necessary, by translating key concepts into the students' mother language during the classes. Student feedback also indicated that the training sessions were long and at the end of the day it was more difficult to maintain attention and focus. Another challenge appeared during the hospital visits. Engineering students are not future medical staff, and spending too much time in a hospital environment, where patients are present, can be difficult.

5. Conclusions

The Smart Healthcare Engineering project presents an interdisciplinary educational model for preparing engineering students to understand and support modern healthcare systems. The concept responded to the growing need for engineers who can work in hospitals and contribute to medical technology management, infrastructure, safety, maintenance, digital systems and sustainable healthcare services. The teaching methodology creates a relevant learning environment where students can connect engineering knowledge with real healthcare applications. The activities implemented in Spain and Romania showed that students benefit from direct practice to hospital infrastructure, practical demonstrations and collaboration with colleagues from different countries.
The SHEng model can be adapted by other universities interested in healthcare engineering, biomedical engineering, industrial engineering or hospital technology management. Future work will include the

integration of the quantitative evaluation results, the further development of the e-learning platform and the expansion of collaboration between universities and healthcare institutions.

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Education and Society

Promoting Knowledge Exchange between Academic Roles through Third Mission

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Abstract

This paper is based on an empirical research promoted by the University of Turin, aimed at answering the research question about what synergies exist between the institutional missions of teaching, research and Third Mission – the vocation of university to generate societal value – within the lives of faculty members. In compliance with an exploratory sequential mixed design, a first qualitative study was conducted through interviews, subjected to software-assisted content analysis using NVivo. The synergy of knowledge exchange between different academic roles during Third Mission was recognized, thanks to collaborative interaction between people in various academic positions, such as professors, tenured and non-tenured researchers, research technicians, postdoctoral fellows, PhD students. Some faculty members put informally acquired resources and know-how to the service of Third Mission activities. By the respondents' account, interaction between colleagues in different roles – particularly those with generational gaps – and between teachers and students during Third Mission has allowed a two-way exchange. For teachers, it has resulted in the acquisition of extra-academic knowledge, which has proven to be useful in planning new educational experiences, and for junior academics as a formative space in view of faculty life. For students, the active learning prompted by Third Mission initiatives was identified as a synergy between teaching and Third Mission: the respondents found, in their experience, that the participation of students in Third Mission initiatives provided effective learning opportunities, beneficial to better achieving pre-established learning objectives.

Keywords: *Third Mission; Faculty development; Knowledge exchange; Higher education; Active learning*

1. Introduction: the "Third Mission"

Object of the research here presented is "Third Mission", also known, since the beginning of the twenty-first century, as "third stream", "outreach" [4], "engagement and impact" [16], "knowledge valorisation" [5], in Italy called from 2023 "knowledge enhancement" by the National Agency for the evaluation of universities and research (ANVUR). It is the most recent function of higher education to have been recognized, after teaching and research, and consists in the creation of societal value (understood as of economic, social, cultural, environmental nature) *for* and *with* the context in which the institution is located, through the mobilization of academic knowledge as research products and teaching content. The involvement of external stakeholders can happen at various levels, from the transmissive model (university spreading its knowledge to society) to the co-creative one, which implies a university-society collaboration for the generation of new, plural knowledge: Third Mission as a two-way process is also the interpretation that is gaining most ground at an international level [11]. Third mission can be acted out through activities of technology transfer, conservation of artistic and cultural heritage, production and management of public goods, public engagement, open science, continuing education and lifelong learning, clinical trials and all other initiatives for the promotion of sustainability, public healthcare and inclusion, protection of vulnerable groups, contrast of poverty and inequalities.

If many works have been dedicated to the relationship between teaching and research [1], less is known about intersections between teaching, research and third mission, considering the growing development of the concept worldwide, as in the Italian context [3]. Synergies and imbalances are fragmentally recognized on many layers: on a strategical point of view, the vision of the three mission as a virtuous cycle, and not three independent pillars, seems to be a goal for institutions [8]; however, from the perspective of the individual, Third Mission is subordinate to the other two missions, since it is perceived as optional and less rewarding [11, 13], or it is less visible inside the academia, or has less evident connections with some highly abstract disciplinary areas [6]. Nevertheless, inside-academia socialization, like the affiliation with internal university structures, research centres and laboratories, seems to play a pivotal role in the conduct of Third Mission [12].

The research problem arises from the intent to reconstruct elements that proactively contribute to cohesion between missions and, on the other side, disruptive elements. However, this paper aims to present only some selected research results, concerning the role of inside-academia collaboration and knowledge exchange between academic roles during Third Mission activities.

2. Research Design

The research question wonders which synergies exist between Third Mission and the other academic missions, teaching and research, and if some missions prevail over others. Research hypothesis is that, over a decade after institutionalization in Italy as the third institutional mission, imbalances still exist to the detriment of Third Mission and in favor of teaching and research, and synergies between missions are rare. The research objective is to understand the experiences of faculty members, focusing particularly on synergies between research and Third Mission. The objective is pursued through an exploratory sequential mixed design: firstly, a qualitative explorative study, conducted through semi-structured interviews, aimed at investigating the role of Third Mission initiatives in the work life of faculty members and any difficulties in integrating them and carrying them out alongside teaching and research commitments. Transcripts were analyzed accordingly to content analysis [7, 10] using the NVivo software, version 15, and 23 semantic categories were extracted. According to the mixed design, the qualitative part is followed by a second study aimed at quantitatively descript the distribution of the emerging points of view, through a semi-structured questionnaire.
For the qualitative study, the population corresponds to the faculty members of the University of Turin and the sampling technique is non-probabilistic for representative elements, in which representation refers to the number of Departments. The sample size consists in 27 respondents, including 14 associate professors, 5 full professors, 3 tenured researchers, 2 non-tenured researchers, 2 research technicians and one research fellow.
For the quantitative study, population corresponds to faculty members from the University of Turin, La Sapienza of Rome, University of Padua, Alma Mater Studiorum of Bologna, Milano Statale University in Milan, University of Udine, University of Salerno, University Institute for Modern Languages (IULM) of Rome, Université Savoie Mont Blanc in France, University of Glasgow in Scotland, King's College of London in England and University of Applied Sciences and Arts of Southern Switzerland (SUPSI). A non-probabilistic convenience and snowball sampling technique was applied: academic representatives for Third Mission were invited to spread the questionnaire into their department or University, and then questionnaires were collected by voluntary self-completion, for a total sample size of 304 respondents. Respondents resulted to belong mostly to Italian universities (71%), then French universities (27%) and only a few from UK and Switzerland (1.3% and 0.7%). The sample is quite balanced in terms of gender identity (49.7% female, 49.4% male, 0.9% who preferred not to answer), age group (38% from 41 to 50 years old, 29% from 51 to 60 years old, 21% from 31 to 40 years old, 11% from 61 to 70 years old and 1% until 30 years old) and disciplinary field, based on the ERC classification, despite with a prevalence for STEM (31% into Life Sciences, 29% into Physical sciences and engineering, 24% into Social sciences, 12% into Humanities, 4% into an interdisciplinary field), with a teaching experience equal or longer than 10 years for the 69% of respondents and equal or longer than 15 years for the 57%.

3. Results

The role of inside-academia collaboration was identified as crucial for the conduct of Third Mission, in both the qualitative – here tackled in the first instance – and quantitative study. Counting on the support of colleagues makes it possible to carry out Third Mission:

> "… *without collaboration I would have zero activity of Third Mission right now" (*16-RT)

> "… *the importance of having a working group that divides tasks between members (…) nobody can follow everything well, the risk is to do everything bad."* (15-PO)

Also, the presence of peer-to-peer knowledge exchange was confirmed, between both people who know each other through previous experiences and people who met because of Third Mission.
In the first case, the origin of Third Mission initiatives can be informal moments, as casual conversations and "coffee break" situations with known colleagues (20-PA), and Third Mission can be a means to explore interests and discover common ground:

> *"… We had already interacted, but on other matters, not on projects of this kind... This gave me the opportunity to learn about the activities carried out by colleagues who perhaps... whom I did not suspect... I did not assume had an interest in this regard."* (06-PO)

In the second case – faculty members who met because of Third Mission – Third Mission prompts academic socialization that is useful for other academic purposes. In this sense, academic socialization can be considered both an enabler and fallout of Third Mission. Knowledge exchange appears to be particularly relevant in case of interdisciplinary connections, eventually transposable to research, also between social sciences or humanities and STEM sciences (02-PA, 08-PA, 09-RA, 20-PA, 21-PO, 24-PO, 25-PA):

> *"… I collaborate extensively with the Energy Department. Precisely because I met some of these professors during my Third Mission activities."* (09-RA)

> "… *Each of us conducts research, obviously, on related topics. However, starting from our research skills, what we found ourselves focusing on was precisely Third Mission. (…) There are many interdisciplinary and interdepartmental influences, even in that case, which have led to meeting colleagues with whom we are now working on research projects."* (12-PA)

> "… *This event also allowed us to get to know each other, and now we're trying to organize some research activities together, pooling our expertise."* (18-RA)

Besides the integration of fields mastery thanks to peer-to-peer knowledge exchange, Third Mission may require other skills to be deployed than just authority on one, or more, research subjects. This and other reasons may lead some senior figures to seek the support of colleagues with various academic roles: Third Mission creates a space of collaboration between professors and research technicians, who possess specialist expertise in more applied fields (10-RB). Collaboration is also formed with junior faculty members, as research fellows (post-doctoral fellowships, early career fellowships) and even students (PhD students, Master's degree students), belonging to various age groups. In fact, Third Mission was defined in an interview as «a field in which hierarchical roles could be a little more nuanced» (01-RT). In addition to the lack of some skills, another reason for the involvement of other academic roles may be that, while senior figures are burdened by considerable teaching commitments and organizational-managerial tasks deriving from institutional roles, junior figures are less charged and have greater training needs concerning faculty life (07-PA).
Many kinds of knowledge exchange between different academic roles are recognized. Most of them exploit the generation gap as a reflective and generative resource, not only paving the way for dialogue in a more horizontal context, but as an actual contamination of know-hows. These initiatives proved to be an opportunity for senior faculty members to gain confidence in the capability of juniors to take on responsibilities and tackle challenging tasks (11-PA, 12-PA).
Younger people, both junior faculty members and students, detain sought-after competences in outreach and effective communication skills, use of digital tools and audio-video equipment, social media expertise and related codes. Having these kinds of competences inside academia made it possible not to seek external figures and not to invest further financial resources:

> *"In reality, we managed to find the webmaster through a PhD student who agreed to do it for free, because you can't find a webmaster for a year with two thousand euros."* (06-PO)

The support of younger people was found also to be productive to engage primary and secondary school students during public engagement activities (10-RB, 17-TR) and create appropriate social network content (23-PA, 27-TR):

> *"And the second thing is that, in any case, it's an experience for them, and some of them, for example, decided after their PhD that their path would be, I don't know, school teaching, because they really enjoyed working with children, or something*

> *like that, or maybe organizing scientific dissemination events, so... A career, a job, more oriented towards that field."* (15-PO)

An interesting note is the possibility for professors to transpose into academic courses, as teaching tools, what they experienced in Third Mission, being in contact with junior faculty members:

> *"… communication, use of social media, use of various software programs, which, even when used in lessons, become a wonderful way to reach students more effectively…"* (07-PA)

> *"No thought is ever given to internal public engagement, involving all members of the academic community. There are also other actors and resources that are underutilized and that Third Mission could make use of, in a highly efficient and effective manner, which would then reflect on them and thus also become a way of teaching, because they integrate skills and competences that might otherwise remain hidden.*" (24-PO)

Junior faculty members experience a direct involvement, not only in the execution but also design and supervision of the activities (02-PA, 06-PO, 18-RA): respondents often cited the "fresh" ideas that were put on the table by them (08-PA, 17-TR, 19-PA, 22-PO, 27-TR). The benefits they derive from conducting Third Mission are tacit knowledge and background insights about academic culture, career development advice (22-PO), academic socialization and networking between peers (06-PO) and junior/senior (01-RT, 02-PA, 19-PA), effects on motivation and planning of future choices (15-PO).

> *"… She [a professor] involved a postdoc research fellow, so even the juniors began to work together and created some interesting synergies…"* (02-PA)

Professors and other senior faculty members with teaching commitments are not only facilitated in practically conducting Third Mission, but rather Third Mission configures as a form of continuing education for them. The interaction with junior colleagues activates useful reflections on how to innovate and adapt their teaching, as they have to deal with students belonging to progressively more distant generations (06-PO).
For students, Third Mission experiences generate active learning, as they construct knowledge in new dynamic settings *extra-moenia* (17-TR, 18-RA, 24-PO), and put them in condition to mobilize informally acquired competences for academic purposes; Third Mission brings also to students a new perspective on how university can be lived (24-PO). For all actors involved, general benefits can be found in the discovery of research areas and interests other than those already known (02-PA, 14-PA, 19-PA), between senior and junior faculty members as between peers.
The quantitative study controlled frequency distributions of categories emerged from the qualitative study. By the questionnaire's results, collaboration was confirmed to be prevalent. The question "Did Third Mission activities help in establishing contacts with academic colleagues, useful for teaching and research?" (274 total compilations) permitted to indicate whether collaboration happens through the establishment of new contacts, through the exploitation of pre-existing contacts, through both, or if it doesn't happen. 212 respondents (78%) answered that some kind of academic collaboration occurs; between those, 117 respondents (55%) conduct Third Mission with both new academic contacts and known colleagues, 54 (26%) only with known colleagues and 41 (19%) only with new academic contacts.

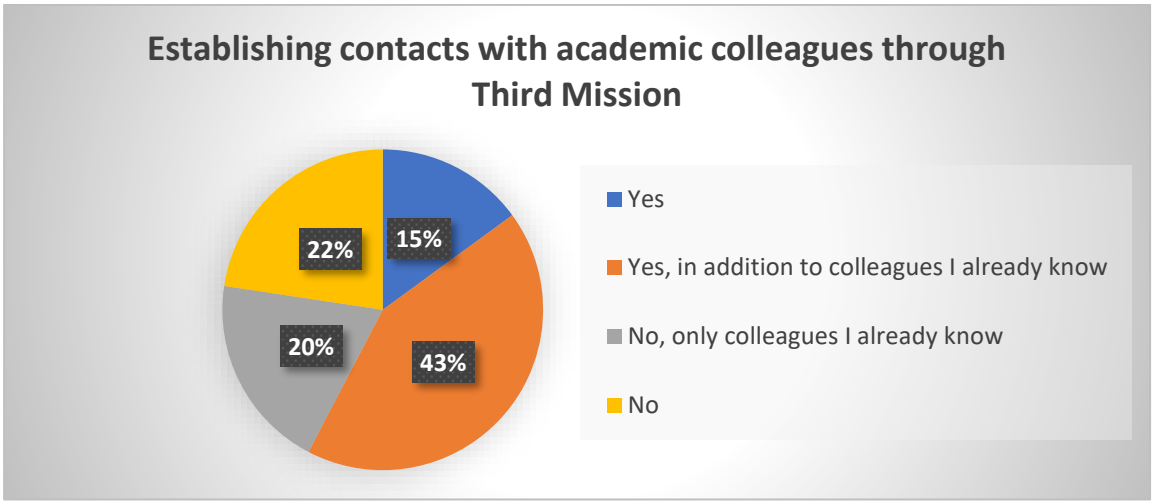


Fig. 1. The chart shows responses to the question: "Did Third Mission activities help in establishing contacts with academic colleagues, useful for teaching and research?" (274 total compilations)

To the question "Did you carry out Third Mission activities together with people in different academic roles from yours?", which received 276 compilations, 254 respondents (92%) answered that it happened, while only 22 (8%) answered that they carried out Third Mission only with people in the same academic role.

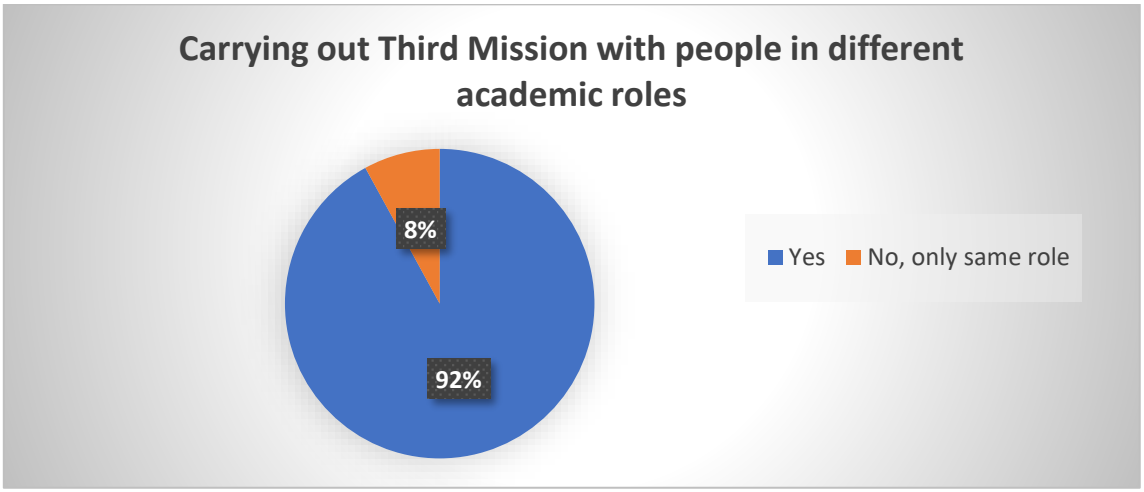


Fig. 2. The chart shows responses to the question "Did you carry out Third Mission activities together with people in different academic roles from yours?" (276 total compilations)

To the question "Did the contact – thanks to Third Mission – with people in different academic roles from yours (eventually including students) give you tools that were useful for teaching and research?", which received 254 compilations, 176 respondents (69%) answered "yes", while 78 respondents (31%) answered "no".

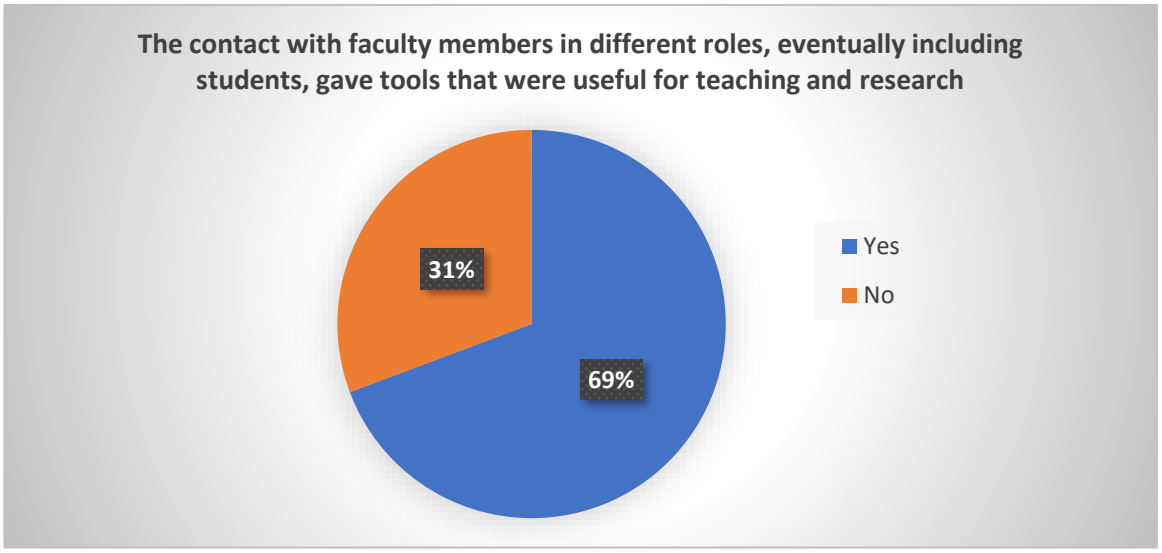


Fig. 3. The chart shows responses to the question "Did the contact – thanks to Third Mission – with people in different academic roles from yours (eventually including students) give you tools that were useful for teaching and research?" (254 total compilations)

4. Limits of Validity and Conclusions

The quantitative study strongly confirmed high frequencies for the qualitative findings related to collaboration during Third Mission and collaboration between different roles, and more than half of respondents engaging in collaborations confirmed that knowledge exchange takes place to various extents. Nonetheless, some limits of validity of the research can be extended to both the qualitative and quantitative study. As regards interviews, a limit consists in the selection of representative elements during the sampling phase, as they are representative of each Department of the University of Turin, but not entirely representative of faculty members, due to the commitment demonstrated in Third Mission. Namely, 16 respondents detain institutional commitments toward Third Mission, that include planning and monitoring of the activities at a departmental level. This could advantage their contribution to the research, because of their overall view of the departmental context, but at the same time, due to their role, they are already positioned and informed actors about the research object. As regards the survey, a bias can be found in the access to compilation, based on interest in Third Mission, as 88.8% reported having conducted Third Mission activities at least once.
Even if other qualitative and quantitative research results attested the presence of still-occurring imbalances in frequence, available resources and perception of Third Mission compared to teaching and research, Third Mission proves to be a channel of learning, for all actors involved, junior as well as senior. New teaching modalities are both implemented and experienced, new insights for future teaching are suggested and reflected upon, informal training and mentorships on faculty life and career are established. Inside-academia collaboration represents a crucial lever to make the most of intersections between missions, valorising the heterogeneity of academic communities.

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Leaning into the Tensions of 'Lived' and 'Living Experience': The Ethics of Representation in the Social Work Classroom

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Abstract

Critical and feminist scholars contending with the ethics of representation in research have asked whether, or not, there is truly an ethical way of representing others. The ethics of representation refers to the good and harm that can result from the ways in which we, as researchers, and I contend here, as educators represent others. As a social work educator, not unlike others, I bring into the classroom examples from the field of the lives and identities of the people, families or communities, disadvantaged along intersecting social dimensions of power, with whom I worked. I do so cognizant that I am representing "Others" who are unable to represent themselves or have been [mis]represented, not only in the education system, but across systems: health and mental health, criminal justice, child welfare, or immigration. I am also cognizant that in the classroom are students with lived or living experiences of the very issues we are interrogating. Although I open classes with a qualifier about emotional triggers, self-care, and the importance of boundaries and of using the space for learning, rather than cathartic release, the acknowledgment of lived or living realities always produces awkward moments and unacknowledged tensions. Against the backdrop of these tensions, in this paper, I consider the implications of the ethics of representation for the classroom and conclude by suggesting decolonial and feminist practices of "multivocality" and of "reflexivity" or "reflection-in-action". I suggest that rather than engaging in voyeuristic learning practices of "gazing at the Other", or passing over the tensions, ***we lean in****, and that the tensions become the "Other-case" for learning with the classroom reconfigured as the field we are aiming to change as social justice-oriented practitioners.*

Keywords: *education, ethics of representation, lived or living experiences, Other or Othering, reflexivity*

Introducing the Tensions: Representations of the "Disadvantaged Other" in the Classroom

Critical and feminist scholars contending with the "ethics of representation" in research have asked whether, or not, there is truly an ethical way of representing others. Broadly, the ethics of representation refers to the good and harm that can result from the ways in which we, as researchers, and I contend here, *as* ***educators****,* represent others, the peoples and communities whose lives and conditions are at the centre of our social justice-oriented work [1], [2], [3], [4]. More than drawing attention to the harms that can come from "how" we represent others, the ethics of representation draw attention to "how who we are" come explicitly or implicitly into those representations, and in turn, cause or uphold harm. Falling under the purview of relational ethics, the ethics of representation align with critical and feminist pedagogies that question the ways curricula, instruction and assessment practices, as well as student-student and student-educator relationships can both uphold or disrupt unjust social relations, processes, and conditions [5], [6], [7], [8]. As a critical social worker and educator, I have always understood and treated the classroom as a microcosm of society – a place and space where racism, classism, sexism, cis-genderism, heterosexism, ableism, sanism, ageism, colonialism, and other forms of oppression, disadvantage, and marginalization are materially and symbolically reproduced and upheld, as well as confronted and resisted [9].

Additionally, my teaching and learning are organized by pedagogies of liberation that emphasize the transformative power of education for students and educators alike, positioned as both learners and knowers. I am committed to "interrogating the power differentials between educators and learners, encouraging empowerment and community building, acknowledging lived experience as 'a way of knowing', and respecting diversity" (p.1547) [10]. Although the academy has long faced criticisms for subjugating and erasing lived and living experiences as important knowledges and ways of knowing [11], critical social work pedagogies consider lived knowledges as important for our theories and training [12], [13] [14], [15]. Not unlike other educators, I bring into the classroom life stories as "case studies" or "cases from the field" of the people, families or communities with whom I worked – the "disadvantaged Other" – who as a structural dimension of their personal and interpersonal experiences were unable to

represent themselves or have been misrepresented, not only in the education system, but across systems: health and mental health, criminal justice, child welfare, or immigration. By bringing into the classroom their stories, lived and living experiences are represented [16], and from there, we engage in reflexive practices of interrogating power and the structural conditions of their lives imagining the changes that could and should occur for a more just society [17], [18], [19].

Additionally, I am cognizant that in the classroom are also students with lived or living experiences of the very issues we are interrogating, issues over which I am expected to demonstrate a certain level of "professional expertise" as a social work and instructor. Although I open sessions with qualifiers about emotional triggers, self-care, and the importance of boundaries and of using the space for learning, rather than cathartic release, the acknowledgment of lived or living experiences can produce awkward moments and unacknowledged tensions. For instance, sharing experiences of "mental illness" can trigger concerns related to the stigma of mental illness and of being judged or constructed as "incompetent" and other sanist microaggressions, such as the use of references like "crazy" or "this is crazy" [20], [21], [22]. Learning about race, racism, and racialization can trigger for white students fears of being called "racist" and shame of being implicated for upholding white supremacy [23], [24], while anti-racist and anti-colonial educators continue to raise concerns about the harms racialized and Indigenous students experience. These harms include microaggressions, such as the covert and overt dismissals of white supremacy and racial discrimination constructing it as issues of the past, or of being constructed as "angry" or as "white-passing" [25], [26], [27], [28], [29].

As an instructor, a major tension I experience is how voyeuristic and self-serving it can sometimes feel working with lived and living experiences (whether it be cases from the field or personalized disclosures) for the purpose of preparing and professionalizing students to become "social workers". From within decolonial studies, "voyeurism" refers to the ways in which the colonial logics of subjugation and erasure in the academy are reproduced and maintained through practices and processes of treating some people, the "disadvantaged Other", as objects to be gazed at, exoticized, and studied [30]. As a critical social worker, I am conscious of how, at times because of "who I am", ***I pass over*** the tensions and ***I lean on students***, racialized and other students with experiences of disadvantage, to verify, uphold, or give legitimacy to the knowledges, representations, and analyses I present as the instructor. Despite the best of intentions, by leaving the tensions unacknowledged and unaddressed, colonialism, white supremacy, and other forms of domination are upheld, reinforced, and reproduced by "who I am". As mentioned, critical and feminist scholars of the ethics of representation question whether, or not, there is truly an ethical way of representing others. They complicate notions of "objectivity" suggesting that the idea of a "neutral" or "unbiased" stance from which we can see and know, and thus, represent the people, communities, and the world is impossible; and instead, we are understood as positioned and located ***within social relations of power*** organized around our race, class, gender, gender identity, sexual orientation, able-mind-bodiedness, age and generation, Indigeneity, and geopolitical geographies and locations. In other words, our representations of others are not apolitical but interconnected and intertwined with "who we are" and with "where we see and know the world" [31], [32], [33], [34].

Ethics of Representation: Moving from Asking "Who Are You" to Asking "What Histories, Relationships, Conditions and Experiences Bring You Here?"

As educators, the choices we make from the topics, theories, films, and reading materials we choose to include in a course, to the assignments, exercises, and activities we encourage or discourage, to the ways we present lived and living experiences are all influenced and organized by our intersecting embodied experiences, our lived and living experiences of our race, class, gender, gender identity, sexual orientation, able-mind-bodiedness, age and generation, Indigeneity, and geopolitical geographies and locations. From a relational perspective, many argue that an ethical practice is "to make our gaze transparent" by disclosing our identities and social positions, not as a list of characteristics, but for ***how*** those categories and positions organize our interpretations and interactions with others [35], [36], [37], [38], [39]. At the opening of and throughout any course I teach, my aims are to facilitate conditions of open-mindedness, humility, and vulnerability for students and myself to open-up, suspend our fears and epistemic arrogance, and learn from one another.

Setting the stage for these conditions, I open courses with "introductions", an exercise of answering the question, "who are you" by sharing our names, pronouns, professional goals, and what we bring to and hope to learn from one another and the course materials. As an initial activity, introductions are an example of how lived and living experiences are invited into the classroom. Moreover, throughout the course students are asked to consider how "who they are" – how the intersecting, interlocking social

dimensions of their embodied experiences inform and organize their analyses and interpretations of the materials, the people, and issues under study. As suggested

> ...you may locate your epistemological claims, theoretical allegiances, and positionality on the various axes of recognized difference, but perhaps you also ought to mull over what your work cultivates and cuts off in you, what brings you to it, what you are looking for and thus likely to find (p. 616) [40].

As noted, revealing our stance by listing the categories or dimensions of our identities is not enough, and instead, questions of "who are you" shift to questions about "what histories, relationships, experiences, and conditions bring you here", bring us to the analyses and interpretations we make? The ethics of representation assert that it is not enough to show how we produce our interpretations, but that we locate ourselves and our interpretations within the ideological and institutional contexts from which the accounts are produced [41], [42].

Informed by this assertion, along with "introductions" I also open courses with a political historicizing, offering "acknowledgements" of the Lands; the Treaties over which the Lands are governed as the legal expectations of settlers (Stewart-Ambo & Yang, 2021); and of the First Nations, Métis, and Inuit peoples (and all other Indigenous nations referring to "Canada" as the context) whom from time and memorial are stewards and caretakers of the territories on which the classroom and university are located. As stated,

> …it is in our most intimate spaces (e.g., our bodies, the people that we are in community with across place, space, and time) that power operates most transparently to reveal its most stubborn dynamics. In declaring these truths, we provide critical knowledge about the politics of power that keep us trapped in the matrix of domination and/or shift us into a matrix of liberation (p. 781) [43].

While my efforts are to shift towards questions about the histories and legacies we carry [44], land acknowledgements are criticized as "performative" and "tokenistic" [45], [46], [47], [48]. Sometimes I feel that along with being voyeuristic, acknowledging lived and living experiences in the classroom is also performative and tokenistic.

Representations of others are the outcomes of epistemological and institutional processes. I understand that unless we reveal our "selves", or perhaps more accurately, our "politicized selves" over "place, space and time" for scrutiny, we run the risk of reproducing the very conditions we are attempting to change – performative educations embedded in colonial logics reproduced onto the bodies of students and other people who are or have been objects of our professional gazes as social workers. Representations reflect certain knowledges and ways of knowing and being, while obscuring and subjugating others. They reflect colonial logics of "singularity" – the filtering of diverse knowledges and ways of knowing and being towards a singular and essentialized way of knowing and being. Rather than engaging in voyeuristic practices of "gazing at the Other" [49], [50], I suggest ***we lean in***, and the tensions become the "Other-case" for learning with the classroom as "the field" we are aiming to change. The reconfiguration of the classroom, as a colonial territory, begins with a stance of "decolonial not knowing" – an epistemological approach for resisting the colonial logics of "singularity".

"Leaning In": Reconfiguration of the Classroom Through a Stance of "Decolonial Not Knowing"

As a social work educator, I am institutionally sanctioned to work with knowledge, specifically with knowledge about the human condition, social problems and their solutions – to produce, share, present, or endorse certain knowledges over others. As an epistemological process, when I present a case from the field – the disadvantaged Other – I take the details of their lives, interpret those details, and then [re]present those details as "knowledge". The same can be said of lived and living experiences of students and educators, alike. As the instructor, I decide what details are important, and in what ways those details should be [re]presented as the "problems" or "solutions" under study. Together, students and educators consider "professionalized", "social work" interpretations of those details and then [re]present those interpretations as "expert knowledge" [51]. In the professionalized "social work" descriptions, the person, their experiences, their communities, and the details of their lives and histories become subjugated, and ultimately unrecognizable against the professionalized renditions [52], [53], [54], [55]. For an action-practice-oriented discipline like social work, I also [re]present that knowledge as personal, interpersonal and social interventions for how the disadvantaged Other should be "treated" – what practices should be used and for what aims.

Ironically, while lived and living experiences in the classroom are ways of recognizing lived knowledges as important, epistemological differences are nonetheless erased through voyeuristic practices of commodifying, reducing, and treating people "as problems" [56]. The person and their conditions

become objects, commodities for learning, and lived and living experiences in the classroom become tokenistic gestures of inclusion and diversity – tokenistic gestures of "social justice". The reconfiguration necessary of the classroom, and of education more broadly, starts with adopting a stance of "not knowing". From studies in cultural humility, "not knowing" is interconnected with ideas of "not acting on our assumptions" and instead, "assuming a posture of not knowing", which then in practice translates to "asking and continuing to ask for clarification", rather than assuming to know the other person [57]. This is what I suggest is the current practice, a problematic practice, for how lived and living experiences are treated in education that inadvertently reproduce the colonial logics of voyeurism, commodification, tokenism, and singularity. Delinking from colonial logics require epistemological versus cultural approaches or practices.

As a way forward, in research, there are calls for moving away from an ethics of representation to an emancipatory ethics grounded in a commitment "that the marginalized have a moral right to own and control knowledge produced about them" (p.p. 48-49) [58]. Others suggest that what is required is a democratization of social relations [59], [60], [61]. In liberatory pedagogies, this moral imperative is also recognized as important [62], [63] and relies on an epistemological (versus cultural) stance of "not knowing" born out of border or borderland epistemologies. Border or borderland epistemologies refer to the knowledges and ways of knowing and being born out of conditions of struggle and resistance to encounters with colonialism and coloniality as systems of domination and subjugation [64]. From border or borderland epistemologies, "not knowing" refers to a posture and practice whereby we "recognize and refuse the epistemic conceits of singularity by inhabiting the undecided situation" [p. 90) [65]. The premise of a "decolonial not knowing" is that we reject arrogance, epistemic arrogance, and the beliefs and practice that we have right to know another person's ways of being, knowing, and knowledges, and in turn are entitled to act on that knowledge and ways of knowing and being as if they are our own. As an educator, I understand the idea of "inhabiting the undecided situation" to mean resisting against approaches and practices of singularity, essentializing and universalizing knowledges and ways of knowing and being, and instead, practicing "decolonial not knowing" through two practices: 1) reclaiming "multivocality" [66] and 2) "reflexivity" as "reflection-in-action" [67] for practices of looking "with" [an]Other, rather than "at" the Other [68].

1) Practicing "Decolonial Not Knowlng": Embracing Multivocality

Rooted in border epistemologies, "multivocality" is anchored in assumptions that there are multiple ways of being, and in turn, multiple ways of knowing and knowledges of the same phenomena [69]. Within this framework, multiplicity and differences are valued, social power is organized and shared horizontally. The aims are not dominance and subjugation, but reciprocity and mutual growth, change, and learning. Multivocality centers practices that are not new, but that are reclaimed from what has always existed, for example, oral traditions of storytelling [70], but were subjugated, suppressed, and targeted for extermination by colonial and imperial violences [71], [72]. As an example of reclaiming multivocality, "encuentros" [translated from Spanish: encounters] are described as a praxis used in the 1980s and 1990s to bring women across Central America together to learn about and share their experiences of participating in revolutionary movements [73]. The "encuentros" were intended to document, support, and address the sexism and androcentrism women revolutionaries had encountered while in their fight for class justice. As a practice, "encuentros" are organized as horizontal exchanges and dialogues with all participants (women, observers, "educators") positioned as "testigos" [witnesses], while the exchange of the experiences is framed as "testigando" [witnessing], and the information shared are "testimonios" [testimonies]. Intentional to addressing the androcentric logics of the revolutionary movements, the erasures of women's epistemologies in their fight for justice, the aims of the "encuentros" were to visiblize the multiple knowledges and ways of knowing, being, and voicing women's experiences.

As a delinking from colonial reductionist logics, the aims are not to make visible the same experience, nor funnel diverse experiences through a process of essentializing, for example towards "best practices", but to make visible multiple voices and multiple realities of the same or similar experiences [74]. The implication for preparing professional social workers is that the classroom and social work training are reimagined, moving away from from being "experts of problems" (the disadvantaged Others) to being "facilitators" and "brokers" of epistemological differences where multiple knowledges and ways of knowing can emerge and flourish as non-hierarchical exchanges and encounters. Critical to building pathways, the aim of social work education shifts from discovering, reducing, and professionalizing (colonial logics) to describing, voicing, and demonstrating complexities that make up the social world and the human condition [75], [76]. Critical for breaking away singularity, the exchanges and encounters

are understood as resulting in more inclusive solutions or responses for addressing inequities because "professional knowledges" or "social work knowing" emerge out of and are constructed from more knowledges and ways of knowing and being, thus, are more inclusive of more epistemologies [77]. Intertwined with practices of multivocality are reflexivity as reflection-in-action for practices of looking "with" [an]Other [78].

2) Practicing "Decolonial Not Knowing": Reflexivity as Reflection-in-action for Practices of Looking "With" [an]Other

Broadly, "reflexivity" refers to a practice of self-reflection that occurs during our interactions with others [79], [80]. Reflexivity is differentiated from other types of reflection, such as reflection-on-action or critical reflection [80]. It is understood as occurring during the interactions, while reflection-on-action occurs looking back on interactions that has already occurred [82]. As a practice, reflection-in-action is useful for interrogating processes as they are occurring. Feminist approaches to reflexivity bring into question our claims to knowledge and to how power is enacted in our interactions and encounters with others [83], [84], [85]. Recognizing that power differences cannot be fully leveled because of the ways in which social roles and institutional power are organized along the social dimensions of a person's identities , the aim of reflexivity is not to erase differences, but to close the epistemological gaps between people [86] by moving each person in the exchange closer and closer to shared understandings of one another without losing or subjugating the "self/other" to one another [87]. Closing the epistemological gap does not mean coming to the same understanding but coming to multiple understandings which include mutual and mutually constructed understandings suggesting a third space. From decolonial or borderland epistemologies, this third space is understood as [an]Other possibility, and involves looking "with" [an]Other rather than treating the Other as an object, for example, of learning or research [88]. The classroom becomes the site for the third space.

The classroom is reconfigured from being a conceptual space of "expert knowledges" and "expert practices" to a space, place, and time for deep dialogue and contemplation where different epistemologies come together and interact with the aims of developing multiple, and some mutual and mutually constructed understandings of the issues, topics, and materials under study. The exchange is no longer conceptual but an exchange that requires us to interrogate our [inter]actions with one another as embodied experiences of one [an]Other as differently positioned learners-knowers [89]. The stance of looking ***with*** [an]Other has all parties in the encounter positioned alongside one another, not of experts of each Other, but as having different knowledges and ways of knowing and being, each epistemology just as relevant and important to the topic under study. Looking with [an]Other means abandoning, or at the very least, resisting notions of "expert" and "expert knowledges" and of knowing and speaking for Others. The classroom as a colonial territory is reconfigured as a space where subjugation and domination of expert knowledges are resisted, and multiple knowledges are embraced resulting in more inclusive solutions or plans for addressing inequities. Again, the implication for preparing professional social workers is that the classroom and social work training are reimagined as moving away from developing "experts of problems" (experts of the disadvantaged Others) to being "facilitators" and "brokers" – accompanying the processes of epistemological differences where multiple knowledges and ways of knowing can converge, emerge, and flourish as non-hierarchical exchanges and encounters and relationships.

Conclusion and Moving Forward

Throughout this paper, the implications of the ethics of representation from research were considered for education, and specifically social work education. To summarize, social work as a discipline is concerned with the human condition, with social, personal, and interpersonal "problems" and their solutions. Moreover, social work is a practice or action-oriented discipline, that is a discipline committed to social change and transformation at the levels of the person, family, communities, and institutions. Representations of others, and in the case of social work, representations of the "disadvantaged Other" are understood as constructions emerging out of colonial logics and epistemological processes: voyeurism, commodification, tokenism, and singularity in the classroom. In liberatory pedagogies, power differentials, empowerment, community-building, lived and living experiences, as well as respecting diversity are all considered important dimensions for producing a more equitable, fair, and just educational system [90]. From the ethics of representation and border epistemologies, we include the democratization of social relations in the academy or what has also been referred to as relational reflexivity [91], [92], [93].

Moving forward, I wonder what it would look like if social work education was reconfigured outside of the academy, and instead, positioned fully in the community with curricula co-designed, co-constructed, and co-delivered with the people and communities we are socially and legally sanctioned to serve and support. While I recognize that many social work educators have lived and living knowledges, as asserted by the ethics of representation, even if we are closest to the issues under study, the representations are constructions that emerge from our positions as university-located and university-positioned educators/learners/professionals. In other words, having lived and living experiences is not an immunity from reproducing, upholding, or being the brunt of colonial logics of commodification, voyeurism, and tokenism in the classroom. By the time we make it to the university, regardless of our backgrounds, we are members of a professional elite, and our representations are constructions that represent our privilege as members of that elite. I am left unsettled by the tensions as they persist, and by the question of how a "decolonial not knowing" through practices of multivocality and reflexivity should be implemented when "social workers" and "social work practices" continue to be born out of the imaginations of "experts", "professionals", "educators", and "researchers" located and positioned primarily in classrooms and university settings? In my efforts to show the importance of lived and living knowledges, what I alluded to but never fully interrogated is the change required at an institutional level, particularly for of how we conceptualize "professional education". In other words, what would it look like if social work education and training for practice was reconfigured outside of the academy and positioned fully in lived and living knowledges as they occur in community in the local contexts and conditions of people's lives and realities?

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Empowering Educational Leaders as Change Catalysts: Strategic Leadership Approaches in VUCA Spectrum

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Abstract

Educational institutions today operate within environments characterized by volatility, uncertainty, complexity, and ambiguity (VUCA), driven by rapid technological change, evolving policies, and large-scale societal disruptions such as pandemics and economic instability. These conditions challenge traditional models of school leadership and require educational leaders to function not merely as administrators but as change catalysts who can foster resilience, innovation, and organizational learning. This study examined how educational leaders in the Division of Sto. Tomas, Batangas adopt and enact strategic leadership approaches to navigate VUCA conditions, and how these practices influence perceived leadership effectiveness and school adaptability. A mixed-methods research design was employed, combining survey questionnaires and semi-structured interviews with 30 school leaders and 100 teachers from public secondary schools. Quantitative data assed the extent of adoption and perceived effectiveness of transformational, distributed, adaptive, and instructional leadership approaches, while qualitative data explored leaders lived experiences, challenges, and adaptive strategies in managing uncertainty. Descriptive and inferential statistical analyses were used alongside thematic analysis to integrate findings. Results revealed that transformational and distributed leadership were the most widely adopted and perceived as very effective in addressing VUCA challenges, while adaptive and instructional leadership were also considered effective. Significant differences in perceived leadership effectiveness were observed across age, educational attainment, and leadership position, suggesting that professional context and role influence leadership perceptions. Qualitative findings further illuminated three core themes: navigating uncertainty through rapid yet compassionate decision-making, leading through complexity by fostering collaboration and shared vision, and demonstrating emotional resilience through empathy, trust-building, and reflective practice. Leaders consistently viewed themselves as mentors who empower teachers, institutionalize organizational learning, and encourage innovation. Integrating the quantitative and qualitative findings led to the development of a Strategic Empowerment Framework emphasizing leadership development, organizational learning, and innovation with resilience. Despite limitations related to scope and self-reported data, the study offers practical implications for leadership development, policy formulation, and professional learning systems. Overall, the findings underscore that adaptive, emotionally intelligent, and collaborative leadership is essential for enabling schools to thrive within the evolving demands of VUCA educational and societal contexts.

Keywords: *VUCA Environment, Educational Leadership, Transformational Leadership, Distributed Leadership, Organizational Resilience, Education and Society*

1. Introduction

Educational systems in the 21st century operate amid rapid technological change, shifting policy demands, and global disruptions such as pandemics and economic instability. These conditions place schools within a volatile, uncertain, complex, and ambiguous (VUCA) environment, where traditional leadership models are increasingly insufficient. Educational leaders are therefore required to balance innovation with stability while addressing persistent challenges related to equity, access, and organizational sustainability. The central issue is not the existence of VUCA conditions, but how leaders respond to them. Without adaptive and forward-thinking leadership, schools risk functioning reactively rather than strategically. As such, educational leaders are increasingly expected to act as change catalysts, individuals who anticipate disruption, mobilize stakeholders, and guide institutions toward resilience and long-term improvement. Recent studies emphasize the importance of leadership competencies such as agility, collaboration, vision, and adaptive decision-making in VUCA contexts (Estillore, 2022). Philippine-based research further suggests that collaborative leadership structures enhance teacher productivity and self-efficacy during periods of uncertainty. Theoretical literature

likewise underscores the relevance of transformational and adaptive leadership, highlighting the role of innovation, systems thinking, and tolerance for ambiguity in sustaining institutional effectiveness. Applying these perspectives to the Division of Sto. Tomas, Batangas is particularly relevant. As a rapidly developing city with growing student populations and diverse educational needs, Sto. Tomas schools experience both the challenges and opportunities associated with VUCA environments. Although localized empirical studies remain limited, existing Philippine research demonstrates that professional development initiatives and transformational leadership practices strengthen trust, motivation, and adaptive capacity among educators. Despite these insights, notable research gaps persist. Few studies examine how school leaders in mid-sized Philippine cities enact VUCA leadership in daily practice or how local context, institutional history, and resource constraints shape adaptive leadership. Additionally, limited research investigates the sustainability of VUCA-responsive leadership practices or their long-term effects on student outcomes. Addressing these gaps through localized quantitative and qualitative inquiry is essential for developing context-responsive and transferable leadership frameworks. This study responds to these needs by examining how educational leaders in Sto. Tomas navigate VUCA conditions and how strategic leadership approaches empower them to function as change catalysts.

1.2 Statement of the Problem

This study examines how educational leaders can be empowered as change catalysts through strategic leadership approaches in navigating the VUCA spectrum. Specifically, it seeks to determine:

1. The demographic and professional profile of educational leaders.
2. The strategic leadership approaches commonly adopted in VUCA conditions.
3. The perceived effectiveness of these leadership approaches.
4. Differences in perceived effectiveness when grouped by demographic and professional profile.
5. The lived experiences and adaptive strategies of educational leaders in managing VUCA challenges.
6. How leaders view their role as change catalysts?
7. The strategic empowerment framework that can be developed based on the findings.

1.3 Hypothesis

H_0: There is no significant difference in the effectiveness of transformational and distributed leadership approaches compared to traditional leadership approaches in navigating VUCA challenges.

1.4 Significance of the Study

- Educational Leaders: Provides insights into adaptive leadership strategies.
- Teachers: Promotes collaboration, innovation, and resilience.
- Policymakers: Informs leadership development and education policy.
- Future Researchers: Serves as a basis for further leadership studies in VUCA contexts.

1.5 Scope and Limitations

The study focuses on public secondary school leaders and teachers in the Division of Sto. Tomas, Batangas. It examines leadership practices, perceptions, and adaptive strategies. Limitations include purposive sampling and reliance on self-reported data, which may affect generalizability.

2. Methodology

2.1 Research Design

This study employed a mixed-method design focusing on surveys and interviews to gain a comprehensive understanding of leadership practices in VUCA environments.

2.2 Participants

Participants included 30 school leaders (principals, assistant principals, department heads) and 100 teachers from selected public secondary schools in the Department of Education (DepED) Division of Sto. Tomas.

2.3 Research Instrument

The researcher utilized a survey questionnaire to measure the leadership styles, adaptive strategies, and school resilience indicators. However, the interview guide questions are also used to gather deeper insights into challenges and innovative practices.

2.4 Data Collection

Data were collected through online and face-to-face surveys, followed by semi-structured interviews with selected participants. Ethical considerations such as confidentiality and informed consent were strictly observed.

2.5 Data Analysis

The quantitative data were analyzed using descriptive and inferential statistical methods to address the study's specific objectives:

1. Descriptive Statistics such as frequency, percentage, mean, and standard deviation were utilized to summarize and describe the demographic and professional profiles of the respondents, as well as their responses regarding the extent of adoption and perceived effectiveness of various leadership approaches (transformational, distributed, adaptive, and instructional) in navigating VUCA conditions.
2. Analysis of Variance (ANOVA) or t-test (depending on the number of groups) was employed to examine whether the perceived effectiveness of leadership approaches differs significantly when respondents are grouped according to their demographic and professional characteristics.
3. Data Familiarization used to transcribe interviews and written narratives were repeatedly read to gain a deep understanding of the participants' perspectives.
4. Initial Coding used for key phrases, words, and ideas were coded to identify meaningful data segments related to leadership practices, empowerment, and VUCA experiences.
5. Theme Generation the codes were organized into broader themes and sub-themes reflecting patterns.

3. Results and Discussion

Table 1. Demographic and Professional Profile of Respondents

Profile Variable	Category	Frequency (f)	Percentage (%)
Age	25-34 years old	36	27.7
	35-44 years old	44	33.8
	45 years old and above	32	24.6
	51 years old and above	18	13.8
Sex	Male	52	40.0
	Female	78	60.0
Civil Status	Single	46	35.4
	Married	84	64.6
Educational Attainment	Bachelor's Degree	59	45.4
	Master's Degree	58	44.6
	Doctorate Degree	13	10
Position/Designation	Principal	10	7.7
	Assistant Principal	8	6.2
	Department Head	12	9.2
	Teacher	100	76.9
Length of Service	1-5 years	33	25.4
	6-10 years	47	36.2
	11-15 years	30	23.1
	Above 15 years	20	15.4

Table 1 presents the demographic and professional profile of the respondents. Most participants fall within the 31-40 age range (33.8%), with 60.0% female and 64.6% married, indicating a professionally mature workforce. Nearly equal proportions hold bachelor's degree (45.4%) and master's degrees (44.6%), reflecting strong academic preparation. The majority of respondents are teachers (76.9%),

while 23.1% occupy formal leadership positions. More than half of the participants (51.6%) have over six years of service, suggesting substantial professional experience. Collectively, these characteristics indicate a stable and competent educational workforce capable of responding to the demands of volatile and unpredictable educational environments. This finding aligns with Suryarati (2021), who reported that educators with higher academic qualifications and longer professional experience demonstrate stronger reflective decision-making, collaboration, and adaptive capacity key competencies for leadership effectiveness in VUCA contexts.

Table 2. Extent of Adoption of Strategic Leadership Approaches

Leadership Approach	Mean	SD	Verbal Interpretation
Transformational Leadership	4.35	0.58	Very Highly Adopted
Distributed Leadership	4.18	0.62	Highly Adopted
Adaptive Leadership	4.10	0.60	Highly Adopted
Instructional Leadership	3.98	0.72	Highly Adopted
Overall Mean	4.15		Highly Adopted

Table 2 presents the extent of adoption of strategic leadership approaches. Transformational leadership emerged as the most adapted approach (M=4.35, SD=0.58; Very Highly Adopted), followed by distributed leadership (M=4.18, SD=0.62; Highly Adopted) Adaptive leadership (M=4.10, SD=0.60) and instructional leadership (M=3.98, SD=0.72) ranked lower but remained highly adopted. These results indicate that educational leaders prioritize vision-driven and collaborative practices while maintaining responsiveness to uncertainty. The predominance of transformational leadership supports previous findings emphasizing its role in enhancing teacher motivation, organizational commitment, and openness to innovation. Aboramadan (2020) notes that transformational leadership strengthens trust and shared purpose, enabling leaders to guide institutions effectively through volatile and ambiguous conditions. This leadership approach fosters collaboration, adaptability, and continuous learning core competencies for navigating VUCA environments.

Table 3. Perceived Effectiveness of Leadership Approaches

Leadership Approach	Mean	SD	Verbal Interpretation
Transformational Leadership	4.42	0.55	Very Effective
Distributed Leadership	4.25	0.63	Very Effective
Adaptive Leadership	4.18	0.61	Effective
Instructional Leadership	4.00	0.70	Effective
Overall Mean	4.21		Very Effective

Table 3 presents the perceived effectiveness of leadership approaches in managing VUCA challenges. Transformational leadership was rated a very effective (M=4.42), while distributed leadership was assessed also very effective (M=4.25). Adaptive leadership (M=4.18) and instructional leadership (M=4.00) were also rated as effective. The overall mean score (M-4.21) indicates that leadership strategies are generally perceived as very effective in addressing current VUCA challenges. The strong ratings for transformational and distributed leadership underscore their critical role in enabling schools to adapt and perform effectively under uncertainty. This finding aligns with Nguyen et. al. (2021), who emphasize that these leadership approaches promote collaborative problem-solving, shared responsibility, and professional teamwork. While transformational leadership motivates and inspires through shared vision, distributed leadership empowers educators through collective decision-making. Together, these complementary strategies enhance institutional resilience and sustain performance and innovation amid VUCA disruptions.

Table 4. Difference in Perceived Effectiveness by Profile Variable

Profile Variable	Computed Value	p-value	Decision	Interpretation
Age	2.15	0.041	Significant	Varying perceptions across age groups
Sex	1.23	0.228	Non-Significant	Same perception across sexes
Educational Attainment	3.02	0.018	Significant	Perception differs by educational level
Position/Designation	2.77	0.032	Significant	Role influences perception
Length of Service	1.45	0.212	Non-Significant	Similar perceptions regardless of tenure

Table 4 indicates significant differences in perceived leadership effectiveness when respondents are grouped according to age, educational attainment, and position, while no significant differences were found when grouped by gender or length of service. These results suggest that professional maturity, academic background, and leadership role significantly influence how leadership effectiveness is evaluated in VUCA contexts. In relation to the study hypothesis, the findings partially reject the null hypothesis, as differences in perceptions of leadership effectiveness exist across key demographic and professional variables. Respondents who are older, hold higher academic qualifications, or occupy leadership positions may possess broader experiential and theoretical perspectives, resulting in more critical or informed assessments of leadership strategies. Conversely, the absence of significant differences by gender and length of service indicates that leadership effectiveness is not influenced by these factors. These findings support Zembylas (2021), who emphasized that leadership perceptions vary according to professional roles and responsibilities, particularly in uncertain and complex environments. Overall, the results highlight the importance of contextual and role-based considerations in evaluating leadership effectiveness and reinforce the need for differentiated leadership development strategies in VUCA educational settings.

Table 5. Emergent Themes on Lived Experiences

Main Themes	Subthemes	Description/Illustrative Statement
Navigating Uncertainty	Crisis Communication, Decision Agility	"We must decide quickly without complete data but with compassion and trust."
Leading through Complexity	Collaboration and Shared Vision	"We engage our teachers to co-create solutions to unpredictable challenges"
Emotional Resilience	Empathy, Self-reflection	"I learned to stay calm and reassure my staff amid fear and confusion.)

Table 5 presents the qualitative findings on the lived experiences of educational leaders in navigating VUCA conditions. Three major themes emerged: navigating uncertainty, leading through complexity, and emotional resilience. These themes reflect leaders' ability to make timely decisions with compassion, engage stakeholders in collaboration problem-solving, and maintain emotional stability during periods of disruption. The findings emphasize that effective leadership in VUCA contexts extends beyond technical management skills and relies heavily on relational and emotional competencies. Leaders who demonstrate composure, empathy, clear communication, and shared vision are better able to sustain trust and morale within their organizations. This aligns with Leithwood et al. (2021), who found that emotionally intelligent and collaborative leadership practices significantly enhance organizational resilience and staff-well-being, particularly during crises such as the COVID-19 pandemic. Overall, the results highlight in VUCA environments as a human-centered and adaptive process grounded in empathy, trust, and collective purpose.

Table 6. Themes on Leadership as Change Catalyst

Themes	Illustrative Statements	Implication
Empowering Teachers	"I see myself as a mentor who nurtures confidence among my team."	Leadership empowerment drives teacher engagement
Building Organizational Learning	"We document best practices and share them school-wide."	Continuous learning fosters adaptive culture
Promoting Innovation	"We experiment with new teaching models and embrace digital tools."	Innovative leadership enhances VUCA readiness

Table 6 highlights that educational leaders view themselves as active agents of change. Respondents emphasized their role in empowering teachers, fostering organizational learning, and promoting innovation to sustain school improvement in VUCA environments. As mentor, leaders build teacher confidence, support professional growth, and encourage experimentation with new pedagogical approaches and educational technologies. The findings further indicate that empowering leadership practices and reflective processes enhance both organizational performance and resilience. This aligns with Harris and Jones (2020), who noted that imaginative and empowering leadership strengthens teacher agency, professional collaboration, and adaptive capacity in challenging educational contexts. Overall, the results suggest that effective leaders do not merely manage change but enable others to lead and innovate, positioning schools for continuous improvement and future readiness.

Table 7. Proposed Strategic Empowerment Framework

Core Dimension	Key Strategies	Derived from Findings
Leadership Development	Continuous training in adaptive and transformational leadership	High Adoption, Empowerment themes
Organizational Learning	Knowledge sharing, mentoring, reflection sessions	Collaboration and learning
Innovation and Resilience	Encourage experimentation, technology integration, flexible policies	Effectiveness ratings, Innovation insights

Table 7 presents the Strategic Empowerment Framework, which emphasizes three interconnected components: leadership development, organizational learning, and innovation and resilience. Together, these elements strengthen educational leaders' capacity to navigate volatile, uncertain, complex, and ambiguous (VUCA) environments. Continuous professional development in transformational and adaptive leadership prepares leaders to respond to rapid change while inspiring collective action toward shared goals. The framework also highlights the importance of collaborative organizational learning through mentoring, reflection, and knowledge sharing, which enhances collective adaptability. In addition, the promotion of innovation, effective use of digital technologies, and flexible policy implementation support institutional resilience during periods of uncertainty. These findings align with Berkovich and Eyal (2021), who argued that empowerment-based leadership frameworks grounded in continuous learning and innovation enhance leaders' self-efficacy, adaptability, and collaborative competence. Overall, the framework supports the transformation of schools into resilient learning organizations capable of managing complex educational challenges.

4. Summary of Findings, Conclusions, and Recommendations

4.1 Summary of Findings

The findings indicate that the respondents are predominantly mid-career, academically qualified, and professionally experienced, providing a strong foundation for leadership in complex educational settings. Transformational leadership emerged as the most frequently adopted approach (M=4.35), followed by distributed (M=4.18) adaptive (M=4.10), and instructional leadership (M=3.98), reflecting leaders' emphasis on collaboration, shared vision, and empowerment in VUCA contexts. Overall, leadership strategies were perceived as high effective (M=4.21), with transformational (M=4.42) and distributed leadership (M=4.25) rated very effective. Significant differences in perceived leadership effectiveness were found across age, educational attainment, and position, but not across gender or length of service, suggesting that professional maturity and leadership role influence leadership evaluation. Qualitative findings revealed three dominant themes: navigating uncertainty, leading through complexity and emotional resilience, highlighting the importance of empathy collaboration, and adaptive decision-making. Educational leaders viewed themselves as change catalysts, emphasizing teacher empowerment, organizational learning, and innovation, which informed the development of a Strategic Empowerment Framework integrating leadership development, organizational learning, innovation, and resilience to strengthen leadership effectiveness in VUCA environments.

4.2 Conclusions

The study concludes that educational leaders in the Division of Sto. Tomas are academically prepared and professionally experienced, providing a strong foundation for managing complex and uncertain school environments. Transformational and distributed leadership emerged as the most prevalent and effective approaches, highlighting the importance of collaboration, shared vision, and empowerment in navigating VUCA conditions. Leadership effectiveness was influenced by age, educational attainment, and position, underscoring the role of professional maturity in leadership judgment. The findings further emphasize the human dimension of leadership particularly emotional intelligence, empathy, and communication as critical to sustaining trust and morale during periods of disruption. Overall, fostering organizational learning, innovation, and teacher empowerment enhances institutional resilience, while the Strategic Empowerment Framework offers a practical model for strengthening leadership capacity and supporting continuous professional development in VUCA educational contexts

4.3 Recommendations

Educational institutions and the Department of Education should implement comprehensive leadership development programs emphasizing transformational, adaptive, and distributed leadership to strengthen leaders' capacity to manage VUCA conditions. School divisions are encouraged to support continuing professional education through scholarships, leadership seminars, and research mentorships to enhance academic and leadership competencies. Leadership evaluation and mentoring systems should be institutionalized to support succession planning and sustained leadership growth. Schools should also foster a culture of collaboration and organizational learning through reflective practices, teamwork, and cross-departmental initiatives. In addition, providing emotional resilience training and psychosocial support is essential to help leaders manage stress and uncertainty. Educational institutions should adopt flexible and innovation-oriented policies that encourage experimentation and the integration of new pedagogies and technologies. Finally, the Strategic Empowerment Framework should be adopted as a guide for leadership development, performance assessment, and professional learning communities to cultivate empowered, resilient, and future-ready educational leaders in VUCA environments.

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Short and Long-term Impacts of School Safety Drills: Student and Family Perspectives

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Abstract

In the United States, school shootings have become more prevalent over the past 40 years. In response, legislators and schools have added various policies and expectations for various safety drills, often named "active shooter" or "code red" drills, to their existing weather-related safety drills. While some research exists regarding how active shooter drills impact students, there little understanding how active shooter drills impact children and their families, let alone creating student- and family-centered practices. This paper presents persepctives of students and their families on their experiences with these drills.

Keywords: *Trauma, School Safety, Student perspectives, family perspectives, school shootings*

In the 2020-2021 school year there were 41 school deaths which included 20 homicides and 17 suicides. From 2000-2022, 131 school students were killed and 197 injured in active shooter incidents. In those 22 years, only 5 years saw zero active shooter incidents. Two of those years saw 5-6 active shooter incidents in schools.

Drill History

In 1999, high school students murdered 12 students and one teacher, with the gunmen dying by suicide. This event is frequently noted as the "watershed" moment that made legislators realize school safety laws were required (evolution of state school safety). Subsequently, numerous other school shootings have occurred, and legislators have passed regulations, and statues to attempt to prevent further school shootings. Most of the current school safety laws are reactive strategies rather than preventative strategies. One response strategy that is not normalized in U.S. schools are school shooter or "code red" drills during normal school days and throughout the school year. While active shooter preparedness is one important component to these far-too normal tragedies, the federal Departments of Education, Health and Human Services, Justice, and Homeland Security identify six other practices that should be equally focused on to prevent future school shootings (evolution document): character development and connectedness specifically mentioning multitiered systems of support (MTSS) and positive behavior interventions and supports (PBIS), preventing cyberbullying, mental health services, reporting and threat assessment systems, educator training, and security of buildings. According to Child Trends and EMT Associates Analysis of state statues May 2019- in evolution document), multi-hazard drills as mentioned above, and active shooter drills are encouraged or required in numerous states. The trend for both has increased over time with 42 states requiring training for hazards as of 2019 and 37 states requiring active shooter drills as of 2024. Oftentimes active shooter drill training frequency and procedures are decided on by individual school districts and sometimes in cooperation with their local law enforcement department. It has been recommended that local officers receive a minimum of eight hours of specific school active shooter training that pair with already required trainings for students and teachers. Gaps in consistent, systematic local law enforcement training put the oneness of active shooter preparation back on educators and students.

What are Active Shooter Drills?

First, it is important to note that there are various safety drills and terms for safety drills used in schools that are often conflated with one another [1]. Some of these terms include active shooter drills, lockdown or emergency lockdown drills, armed assailant training [1], live exercises, and school preparedness drills. The National Association of school Psychologist (NASP) and the National Association of school Resource Officers (NASRO) (2017) note that the term "active shooter drills" has "become an unhelpful catch all" for "very different types of drills," including: "options-based drills" where students are taught to run, hide, or fight; simulation drills where there are "sensorial components" such as sounds and actors

playing roles; and lockdown drills where students shelter in place (p. 2). Yet, because students, schools, and the literature base widely use these terms interchangeably [2] we do not distinguish a difference in these drills. We define "active shooter drill" to mean a planned set of school activities that are organized by school leadership and faculty/staff, such as teachers and school counselors, who mimic the possible scenario and safety procedures in the event of an active assailant on or near a school campus.

Concerns about Active Shooter Drills

Though active shooter drills in their various forms have been implemented for many years in American public schools [1] there are many concerns about these drills including: a) the blurring student and faculty roles and responsibilities during drills, b) their overall effectiveness to promote/increase student safety, and c) leading to cause additional stress or trauma for students and staff.

Blurring Student and Faculty Roles and Responsibilities

One concern about active shooter drills is that students and are being saddled with the responsibility to act as a defense for themselves and their classmates in danger, especially students who may or may not have the development understanding or ability to do so [3]. Guidance from the National Association of School Psychologists, the National Association of School Resource Officers, and Safe and Sound Schools emphasize that "at no point should students be given the instruction or impression that they are expected to act as heroes (i.e., fight, defend, counter) in a life-threatening situation" (p. 7). Additionally, one of the weak modes of implementation observed in the practice of school lockdown drills is the failure to provide accurate orientation for the students and their parents by the school authorities and the use of school counselors against their primary role towards the students [3].

Overall Effectiveness to Promote Student Safety

Current research shows mixed effectiveness of active shooter drills for student safety [1] [2]. In fact, 2021 study [4] on the impact of school shooters drills on the psychological well-being of American K-12 schools and communities with the use of machine learning and interrupted time series analysis which filtered 54 million social media posts, in 114 schools, spanning 33 states shows a 39-42% increase in the level of anxiety, stress and depression in the school communities. The mental well-being of the American K-12 school students is perceived to be threatened by the popular acceptance and implementation of school shooters drills. The drill is carried out by school administrators to prepare the school population which includes, the students, teachers and other school officials and staffs against random shooting. Students report an 39-42% increase in the level of anxiety, stress and depression around active shooter drills.

Causing Additional Stress or Trauma for Students and Staff

One of the biggest concerns about active shooter drills is the potential for these drills to cause emotional stress and trauma such as fear, anxiety, and worry from students, parents and counselors [1] [2]. Teachers can and should help students understand how to respond to an emergency situation without causing undue emotional stress; in fact, there are numerous steps that have been suggested to teach students of various ages and developmental levels about drills without students actively having to engage in a typical active shooter drill. The National Association of school Psychologist (NASP) and the National Association of school Resource Officers (NASRO) (2017) hold the view that schools who are implementing the lockdown drill as a safety measure should consider the psychological effect the drill might have on students by putting into the realization of their plans an effective precautionary measures and emotional care. In fact, it has been noted that if these drills are “not implemented correctly, they can cause (psychological) harm” to students and teachers (2021, p. 1).

Purpose

While the field works to prevent school shootings, it is clear that active shooter preparation is still required for U. S. teachers and students in addition to local law enforcement. However, less is known about the balance of effectiveness and harm done with students participating in active shooter drills as they are currently implemented in the U.S. Thus, our purpose of the current study is to better understand the perceptions of students and families participating in multi-hazard and active shooter drills, their

impacts, and potential lessons to learn to reduce harm while ensuring effectiveness. This is a single district case study that examines both qualitative and quantitative data from students and caregivers. This multi-informant, multi-method study provides a comprehensive glance of problems, perceptions, and strategies for improvement.

Method

Because of the limited prior research on student and parent perceptions of school safety and experiences with school safety drills, we used a constructivist perspective rooted in grounded theory (Charmaz 2006; 2014). This perspective allowed us to conduct an inductive analysis to discover patterns in participant perspectives and insights of school safety drills and overall school safety. This allowed us to view patterns in the data without implementing pre-determined categories onto the data, which allowed findings to emerge inductively from the data sets.

Setting

We conducted this study from a southeastern state that has seen increases in weapons in K-12 campuses, including 144 incidents of students possessing and/or using a gun (of any type) on school grounds during the 2022-2023 school year. We conducted the study with parents and students from midwest and southeastern states with various cultural and political values regarding gun control and use. Additionally, participants varied in their own exposure to or experience with the use of guns and/or gun violence in their schools and private lives. Though some participants may have disclosed opinions and values on guns and gun culture in the online survey or during interviews, the investigators did not specifically ask questions about the parent, student, or family's personal views on the matter because the study was focused on school safety and active shooter drills rather than personal and cultural views on guns and gun control.

Participants

We recruited parents and/or caregivers (e.g., foster parents, custodial grandparents) of Pre-K through 8th grade students who participated in at least one active shooter/school safety drill during the 2023-2024 school year. In December of 2023, we began recruitment through social media posts for the study, as well as through snowball sampling via these posts being shared and others referred to the study from public shares of the original post(s) online (Johnson, 2014). Parents/caregivers were directed to an online consent form and online survey to complete, where the initial survey included an option for the parent/caregiver to express interest in participating in a follow-up interview with researchers, either alone or as a dyad with their child(ren). The online survey and interviews were administered from spring of 2024 through the end of 2024. A total of fifty-five participants agreed to the online consent and at least partially completed the online survey. Sixteen participants (eleven parents and five students) consented to and completed an online interview. We did not have a set number of desired participants, but rather we consulted the data as interviews were conducted, and stopped seeking participants when we concluded there was a point of saturation with the data and data analysis (Saunders et al., 2017).

Data Collection

In this study we used two primary forms of data collection: an online survey and individual/dyad interviews. The online survey incorporated open-ended and short answer questions to provide a way to collect descriptive data from the participants, including basic demographic information and their experiences with, and related thoughts and feelings about, active shooter drills (Creswell & Poth, 2018; Patton, 2015). The interview protocol was developed in a semi-structured manner with predetermined guiding questions to further explore the perspective of parents and students individually or in dyads on active shooter drills in schools. An example of the interview protocol can be viewed in Appendix 2. Again, we did not have a set number of desired interviews, but rather we consulted the data as interviews were conducted, and stopped seeking participants when we concluded there was a point of saturation with the iterative data analysis.

Data Analysis Plan

Because the goal of this project was to capture participant perceptions, we used inductive analysis with multiple, iterative rounds of reading through and coding the data. Throughout the data analysis process, we used a collaborative, constant comparative analysis approach to identify patterns in the interview data. First, we acquainted ourselves with the data by reading through a few of the interview transcripts. We then used In Vivo coding with the participants' own words and phrases used to generate potential main codes and sub-codes from the interview transcripts. When the first round of coding was complete, we met as a team to review these codes and resolve any disagreements or questions about the codes created. We created a codebook that included the main codes, subcodes, and examples of these codes. Next, we reviewed the data with these main codes and sub-codes in mind, and repeated the process of meeting and resolving any disagreements or questions from the second round of coding to reach consensus on the coding processes. Additionally, the team read through the survey data and coded the data with the existing main codes and sub-codes. Because the survey data was less in-depth, the interview transcripts were used as the main source of data, with the surveys used as supplements to the interview transcripts.

Researcher Reflexivity

We recognize that research is not neutral, and our collective backgrounds and experiences informed how we approached this study. The first author has a counseling and art education background. The second author has a background in early childhood special education, and had reservations about how 'active threat' drills were conducted both as a preschool teacher and as a parent. The third researcher is a parent of children who have experienced school safety drills and focuses their research on the social, emotional, behavioral wellbeing of teachers and students.

Findings

We identified key themes corresponding to each research question. Each theme is described in the following sections. All participants are assigned numbers.

Student Perceptions of Safety Drills

For the most part, students largely expressed ambivalent feelings towards fire and tornado drills. They described being familiar with the routines and procedures. Despite the variance in participant ages and locations, these types of drills were described almost identically across students, e.g., having to leave the classroom for a fire drill, having to bend down and protect their heads for a tornado drill, teachers doing a 'head count.' Some children did note that they did not like the noise associated with fire drills, for example, P4 shared "It scares me sometimes, because the alarms are so loud." There was much more variance in how students described 'safety' or 'code red' drills, and expressed more of a sense of being afraid during these types of drills, such as P5: "I feel scared…I don't like dark…your teacher would like put black paper over the window on your door." P2 described having to hide:

> We have to get down and be very, very quiet…and we have to hide in a corner. We get behind some desks…but [he] could still see us because he would just look, I think he would just look over the tables…the bad guy, if he had a gun, he would just shoot us.

P4 described how procedures were different according to gender:

> Code red they lock your door, turn off the lights, shut the screen. The girls get to go in the closet, and they lock it. The boys have to hide under the desks and like barricade the door. The teacher has a golf club and waits by the door.

Parent Perceptions of Safety Drills

Overall, parents expressed a general sense of their children's safety while at school. For example, P1 shared, "They've never been wronged by anybody at school. So, they're still trusting and believe that the adults at school will take care of them." Parents had a general sense of how drills were conducted, especially fire and tornado, which follow similar procedures to when parents themselves were students. However, they described not having to experience 'school safety' drills as children themselves, and this being a new experience. Parents mostly described learning about 'school safety' drills from their children, rather than from school communication. For example, P3 shared how 10 yearold explained

these drills: “I started asking him questions. He was like, ‘oh yeah, they’re really scary. And you get shot. And you have to stay super quiet, so that the person with the gun doesn’t know where you are.” Another parent shared how these drills have contributed to her daughter’s fears at school when coming across an unfamiliar adult: “She didn’t know this person, it was an adult male, later found out it was a student teacher and it was totally fine and safe…, but she came home and told me about this and said ‘I was so scared he was gonna have a gun.” Other parents also described their children being scared after the drills, such as P9:

> I think she’s really just rattled…once that happens, she’s kinda like, ‘this is all I can think about’, and I think the difference for them is a fire drill or a tornado feels like an an active…beyond anyone’s control. And so, she doesn’t get as nervous for those, those feel more like ‘ok here’s the process. This is how we can stay most safe’. Where is the active shooter drills feels like they know it’s going to be someone that’s known to the school in some form or fashion…and she’s kind of freaked out. She comes home talking about it. You could tell she’s jittery.

P10 noted how she tried to assuage her child’s fears, describing:

> You know, they did have a suicide in their school last year. You know, he lost a close classmate and friend, and that was very upsetting to him. But even before that, he's always felt very uneasy when those drills come up, and it kind of reminds him that someone in his kind of peer group could actually be the aggressor, and that, again, the activities, I think, can make him feel more vulnerable than any might otherwise, right? And again, as a parent, we've tried to explain to him is like, look, this really is in your best interest. We hope this event never occurs. You need to be prepared for this eventuality, just like a fire, just like a a tornado drill. But again, while those are natural effects, this is, you know, kind of a result of, you know, perhaps a peer, perhaps a member of the community you know, in, you know, coming in to do harm indiscriminately. And I think it's the unknowing nature of that that upsets him.

Desired Changes

When asked what if anything they would change about drill procedures at their child’s school, many parents mentioned improved communication, such as P2:

> I wish that we would get notifications beforehand, about the drills. We don't get notifications about fire or tornado drills, but after they've had an active shooter or lockdown drill, then we get the notification. And I sometimes feel like… It's only because they feel obligated because somebody said something about it. It doesn't seem like it's a routine thing. That they tell us about and, every time we do get the notice, it seems reactionary, like. You know, it wasn't… It was in response to a parent who's been upset or their kid has been upset. Um, so I wish that we would just at least just know that, hey you know, hey, we're going to do this. And you know, even if they ask us not to say anything to our children about it, at least when they come home and they talk to us about it, we know how to appropriately respond. Or if, you know, if they did let us know that we could talk to them about it, you know, we could also just remind them how they need to behave or how they need to respond in these situations. So that they know that they don't need to be afraid, that it's just practice…I mean, I know what a fire drill sounds like, but you know, as a child, that's scary and you don't know what's going on. So, if you got a heads up beforehand, either from your parents or for your premier teacher. I think that could ease, some of the you know, the nervousness and the anxiety that they might experience when it's actually comes time to have this…And I am a huge fan of educating yourself about things, you know you know, your surroundings and things that could happen, but I certainly don't want to live in fear and I don't want my children to live in fear, so I think being able to have an active open conversation about it with my children, but also with the educators and the school system you know just so that we know how to address it…we're putting our trust in these educators to make sure that they teach our kids what they need to know, let us help you here. Let us try to…I don't know, do our part as parents to ease this. So, they understand that, you know, we're not trying, no one's trying to scare you on purpose. No one is trying to make this so that you're afraid of everything. We just want you to be aware. And so, I think, you know, together parents and educators, group effort is better, a better approach anyway.

P3 expressed similar feelings:

> Well, the other thing I think, that I probably would have said under I would change is, I think, that parents should be notified before they have these drills. It doesn't even have to be like today at nine o'clock we're gonna do X. But I think it could be helpful to say, especially for kids who are high anxiety like, I can imagine, I mean, this wasn't really an issue with my older son because

> we weren't doing this comes to drills then. But, um, if he were in elementary school now, I think he'd have a lot more anxiety about it. I think it could be helpful to preface that even just like on Monday morning, you know, a note from the principal- "sometime this week we're gonna have a drill." So, it can still be a surprise if that's beneficial, I guess. But, um, where you can talk to your kids about it. Um, I mean, we do this for this the special needs teachers-They know when those drills are coming and they prep those students. And so, um, we just assume that the rest of the student body doesn't also need that. But, um, and if, the if the faculty feels that there's some benefit to it kind of being sprung on you. I mean, okay, I'm not. That's not a hill I'm gonna die on. But also, I think that there's no reason that we can't say like within the next week, so that parents can kind of prep their kids and talk to them about it. And you know, just kind of get them in a better place. So, I mean, if you haven't heard about this drill, if they do, if they truly do it once for a semester. You haven't heard about it since September. It's, it's November, you mean. That's going to be pretty overwhelming. So that's the only other thing I think that. I bring up the community communication around it is pretty abysmal, honestly.

P6:

> They don't communicate. I, I never know if they have a drill or not. Which we…(Crosstalk) In kindergarten was, I did, I did call and complain, and I didn't seem to care, but when he had his first lockdown drill, when I picked him up he was in a mood. And I was like, okay. Got home and I'm like what happened. And he started to cry like what, what happened? He's like "we had this lockdown drill, and we all had a huddle together like at the corner of the classroom, and we thought bad guys were coming, and…" I was like, Oh, wow! And was like, "well, that was just practice, and it's okay." And, but I was, I called because I'm like, could you like next time, like, maybe give warning to parents. I understand they need to be a surprise…Or like right after send us…You send us emails all day long for like pointless things I'm like, can you send us, like, the language you're using to talk to them so we can kind of make it less scary and be on the same page, and it didn't happen this year.

Questioning the Utility of Drills

As they considered what they might change or do differently regarding school safety drills, parents also questioned the utility of these drills given the adverse impact, such as P7 who shared "These things are happening without any consideration of like, how it makes the kids feel." P3 noted:

> I think that research tells us that kids aren't overly… well, the very limited research that is out there, aren't safer necessarily because of these drills. And so, is there really any utility in like banging on doors and yelling out, um, for kids? I mean I think that if we're gonna do that we could do that without students present. Like teachers could practice that like like, there's a teacher in every situation, anyway.

A couple of parents shared that their children would not follow the drill procedures in the event of a real emergency, such as T11:

> Their safety policies actually put them in danger. And I have told them. And I'm not gonna lie. I have told them not to listen to anybody. I said, you hear a gunshot. You run as fast as you can out. And I know that they're trying to prevent chaos, but it also causes them to be sitting ducks, and it's not working, it's just not working. So, I told him, 'Run as fast as you can as far as you can, and then call me, and I will come pick you up.

Other parents shared how their children felt the drills were not effective, such as P9:

> My daughter, who's in high school, came home sort of saying, "This is BS, mom. If, if I know that there's a shooter, if there's some kid that graduated who's coming back to shoot us, I am not staying in the room, there's no way that's happening." So, she kind of took it as like, "I'm not listening to my teachers in that moment. I'm gonna do what I think is best."

P12 shared, "Oh, it goes through their heads. They're smart, they're not. you know. We don't always, as adults give the kids the credit that they deserve. But they're smart. And the boys know, my son's like 'they're useless.'

Finally, one parent suggested that these types of drills be stopped:

> I guess honestly, I feel like they should stop doing the active shooter drills. Um, I think the fire drills, and for us, tornado drills, are, are fairly important… Again, and, and maybe this is my own bias, and that's why my kids feel the same way, but it's like, if there's a fire, they need to know how to get out. Just like they'd need to know how to get out of the house…Like they need to know how to get out of the house if there's really something, you know, they need to know what we're doing as a family. Same thing with the tornado, like they know, like we've had tornado

watches and warnings. There's been touchdowns near us, and so they know, we've, you know we take our food, we go down to the basement. We kind of huddle in the basement. They kind of know what those are about. I don't do, for example, in my house, I don't do, “Hey, if someone breaks into our house, this is what you do,” like…We just don't do that, and maybe it's a… (Pause) maybe that's a shortcoming, I don't know, of our family, but it's like, we talk to them a lot about how to stay safe when they're out in public, and things like that. We talk to them about those types of things. But I I've never felt the need to scare them about, “What if someone breaks into our house with a gun,” you know? (Laughs) And that's a very real possibility. I mean, I live in Chicago. It's a real possibility, um…but we just don't do that. We've never felt the need, so honestly, I wish that we would stop doing the active shooter drills. I also think that they're… an active, an active shooter situation is so volatile that, and it's so different depending on is there one person shooting? Is there multiple kinds of gun? Do they have like… And, and…I don't know. I guess it is gonna be what it's gonna be, do you know what I'm saying? I'm not sure that there's any drill that is going to prepare people for if someone really comes in the school with a gun, I think we can do a better job monitoring our front doors and making sure that people are checking in with the…You know the front desk, whoever is kind of responsible for manning the doors and schools. I don't think we should be saddling our students and our teachers with it. Um… Well, certainly, our students, our teachers, need to know, you know again, how do they stay safe and how do they do the best job they can, keeping our kids safe, I'm just not sure we need to bescaring kids, multiple times a year about this. So, I guess that's the thing that you know when we think about this, like, if our job is as adults, is to provide a safe environment for our students, um, and our teachers and our staff members, then that is where the responsibility lies. And so there should be other things happening at the school to take all precautions necessary to prevent someone coming in and shooting the school up. Not to plan extensive reactive measures for the inevitable. You know what I mean? It's like this shouldn't be the inevitable.

Considerations when Planning Active Shooter Drills

There are several considerations for active shooter drills that are important to keep in mind in relation to practicing these drills in schools and the findings from this case study. First, it is important to note that the planning of active shooter drills must consider the impact of drills on the students, who are direct participants in the drills [1]. NASP emphasized that planning and preparation should be carried out before the lock down drill exercise occurs. One finding highlights the need for additional considerations for students with disabilities, prior trauma, communication issues, and health isues with specific considerations for those involved during the drill and after, as a measure to reduce the observable negative impact that the drill might cause to student's psychological well-being, and to maximize the benefit of safety in carrying out the drill. Also, proper preparation and planning should be carried out by school leadership in collaboration with parents, and teachers in accordance with the type of lockdown which can either be a full-scale lockdown (employed when the students' lives and the school is in imminent danger) or a secured perimeter/lockout (a mild observance of door and window locks). It also emphasized the orientation of students as a means of preparing for lockdown drills. And a reassurance of safety during lockdown with provision of mental health intervention after lockdown drill experiences. School psychologists and other mental health-trained service providers have a critical role in ensuring that the process of active shooting drill in schools is safe and carefully planned with the involvement of police officers as law enforcement agents, who are well educated on the likely danger and adverse effects shooting can have on students, parents, and school administrators; with school Psychologist; who are trained to understand the healthy emotional stability required for the smooth implementation of school active shooting and the school crisis team, can lead to a worst experience of shooting drill exercise. The trauma history of students, staff and schoolteachers is a factor to consider in the planning of school drill. This is because NASP have observed a positive relationship between school shooting drill and reoccurrence of trauma, not just as an immediate negative effect but an occurrence in the future. These negative outcomes of lockdown drills shows that necessary precaution, sensitization and awareness should be done as guideline for positive outcome.

Another important consideration in planning, implementing, and debriefing from active shooter drills are the students who have varying developmental and physical abilities and understanding of the drills. Schools carry the responsibility to not discriminate against a student based on the (dis)ability, age, national origin, or race of students, which includes when forming and implementing the policies and practices of school safety. These students may include students with “mobility challenges,

communication, hearing or sight impairments, heightened sensory or distress reactions, or cognitive impairments may need additional support to fully participate in and benefit from drills," as well as English-language learners. Schools should "not use simulation techniques with students, and exercises should be appropriate to the participants' developmental level and physical abilities". Not only is it important to consider students with clearly documented needs that are connected to disability or assistance, it is also important to consider students (and staff) who may have other needs, "such as previous exposure to trauma," violence, or other life stressors that may be unknown to the staff and/or administration.
Another consideration is the planning, implementation, and effectiveness of active shooter drills. Many schools spend considerable money and time on commercial programs designed as 'Crisis intervention program' to train and equip teachers on the best mode of response to prepare students ahead of crisis. Many of these intervention programs lack an empirical basis to ascertain the effectiveness of their contents. Additionally, researchers have found that the benefit of this drill is not fully determined as it has adverse effects on students' perception, causing emotional instability such as fear, a disturbing feeling of attack and lack of security (Zullig). This calls for the need to carry out evidence-based research to establish the best possible ways for schools to successfully implement lock down drill for maximum benefits while minimizing harm. To ensure that schools comply to the need to successfully implement evident based strategic lock down drill, interventions and organizations like Every town for Gun safety support funds, the American federation of Teachers and National Education Association provides useful information as guidelines to effective lock down drills. A recent publication from NASP highlights numerous strategies to help reduce harm during required active shooter drills including: (a) carefully planning, (b) preparation that includes announcing the drill and account for individual student trauma histories and instruct adults to monitor for stress and trauma responses, (c) during drills providing clear, calm direction with reassurance for students that this is a drill, and (d) after a drill notify families, monitor for stress symptoms, evaluate the lockdown and its impacts.

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Co-Creating the Future City: Imagination and Participation in Formal Education of Students

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Abstract

In the article we illustrate our recent efforts and experience as urban anthropologists and university teachers to encourage future literacy in participatory urban planning among students and residents. Guided by the need to strengthen the links between education and society, i.e. the relationship between academic knowledge and the various societal issues, and to improve participatory and democratic processes in urban planning in Croatia, we have recognized that a step towards the aforementioned could take place within the framework of collaborative projects of the academy and civil society organizations. In the next three years, we intend to connect students, citizens, city governance bodies and the academic community through the research and workshops, using service-learning method. The aim is to design a new syllabus and enhance students' skills for future thinking about the city, public space and governance; to facilitate residents in voicing their needs; to strengthen governance – citizens communication channels and ways of negotiation and involvement. In this article we outline the collaborative project based on service-learning, address the importance of civic participation in urban planning, and discuss the concept of futures literacy in contemporary university education.

Keywords*: urban anthropology, service-learning; futures literacy; participatory urban planning*

Introduction

What kind of cities do we want? This question lies at the core of our ongoing project on contemporary urban transformations of urban visions, practices and ethics in Croatian cities (funded by European Union – NextGenerationEU), which builds upon a prior bilateral project exploring urban futures in several Croatian and Slovenian towns (funded by Croatian Science Foundation, and Slovenian Research and Innovation Agency) (www.citymaking.eu). Both research projects are rooted in urban anthropology (a subfield of cultural anthropology) and are grounded in its qualitative methodology. The Urban Anthropology course is taught at the Faculty of Humanities and Social Sciences at the University of Zagreb focusing not only on theoretical social, cultural and spatial issues but also aiming at developing applied skills and competencies for managing urban social processes. Beyond academic research and university teaching, we collaborate with civil society organizations and various local and urban initiatives. Recently, the cooperation has expanded into the design of a joint educational program based on service-learning. This experiential pedagogical method has not previously been utilized within the Urban Anthropology course, nor within the broader curriculum of the ethnology and cultural anthropology education in Croatia. The new educational program specifically aims to enhance participatory and democratic processes in urban planning in Croatia.

Project PARTICIPARE and Service-learning Method

In collaboration with the initiative *Društvo i prostor* (Society and Space) and the NGO *Pravo na grad* (Right to the City) we have conceptualized the project *PARTICIPARE – Civic Participation and Spatial Planning: Developing Qualitative Approaches, Youth Engagement, and Local Community Involvement*. Within the next three years the project intends to: a) provide a platform for training university teachers and NGO professionals in service-learning pedagogy; b) design a new syllabus integrating the service-learning method with a focus on participatory urban planning within the Urban Anthropology course; c) implement this syllabus to cultivate students' capacities for future thinking about the city, public space and governance; facilitating residents in voicing their needs; and strengthening communication channels, negotiation mechanisms, and engagement strategies between local governance and citizens in participatory planning frameworks.

Service-learning constitutes an established pedagogical method that has been used in higher education for many decades. Our approach adopts a comprehensive definition, conceptualizing service-learning as a "hybrid methodology of socially responsible teaching, collaborative action, and experiential learning that fosters the personal and professional development of students and the community through a partnered, organized, and structured experience of working to resolve social problems in the local community" [3, p. 11]. Precisely its experiential dimension is of particular importance for our approach, as service-learning places equal emphasis on both community service and learning components, with the aim of expanding knowledge and acquiring new skills [15, p. 286].
Furthermore, the service-learning method extends the educational process beyond the classroom, and the conventional teacher-student binary. It introduces the third actor – NGO professionals, who are familiar with current local social needs and experienced in coherent and immanent articulation and problem-solving. The fourth partner is the local community itself. In this setup, service-learning is not only oriented toward fieldwork in the community and the acquisition of personal and methodological skills (by students) but also contributes to community empowerment, influencing social change within the community – primarily through democratic involvement in problem-solving and decision-making processes on relevant issues.
However, one of the method's biggest challenges lies in balancing educational outcomes with social impacts, alongside the potential risk of inadvertently reproducing existing stereotypes and unequal power dynamics [13, p. 9]. "Critical service-learning" represents one of the approaches through which these challenges are addressed, primarily by encouraging continuous critical reflection and collaborative efforts aimed at achieving social justice and social transformation [13, p. 10]. Cultural anthropology also holds the capacity to respond to such concerns, as certain elements of social service-learning align with the core approaches of the ethnographic method, which is at the very heart of the discipline cultural (and urban) anthropology.
Specifically, these convergences encompass fieldwork premises, qualitative interviewing grounded in interpersonal relations, active participation within the studied community, the understanding of local experiences, collaborative approaches, and systematic reflexivity on research process. Precisely because of these qualities, cultural anthropological approach to service-learning holds particular potential for balancing its educational and social dimensions while fostering more critical, socially sensitive, locally grounded, future oriented, and transformative forms of learning and civic participation that are grounded in present social realities. In other words, there are many points of convergence that make service-learning a close and easily applicable method in the teaching of cultural and urban anthropology. These overlaps can be perceived as "a valuable route to melding good anthropological practice and citizen activism with effective teaching and scholarship" [12, p. 6].

Civic Participation in Urban Planning

Within the framework of the Urban Anthropology course, a significant part of learning is devoted to participatory and democratic processes in urban governance, specifically focusing on urban and spatial planning. In many contemporary societies, democracy and participation are mutually constitutive, reinforcing and sustaining one another. In its broadest sense, participation entails citizens 'taking part' (Latin: *pars, partis* + *capere*) in collective social action, while in a narrower political sense, it is vital to democratic systems because it implies the direct involvement of citizens in political and public decision-making processes. Precisely because it constitutes a foundational pillar of civic political subjectivity, integrating the concept of participation into all levels of education is exceptionally important. Namely, participation can be learned experientially through socialization processes, the family environment, and informal education, where various forms of engagement (in the local community, at school, etc.) may not explicitly emphasize participation as a core value but nevertheless build a certain civic *habitus*. Formal education, however, should provide systematic learning about the ways and possibilities of participating in specific spheres of society and political decision-making. Ideally, the integration of formal, non-formal, and informal learning and experience would lead to the acquisition of knowledge and skills on how to achieve participation, as well as the development of attitudes, affects, and moral values regarding the importance of participatory action.
A 2021 study, conducted within the Urban Anthropology course with approximately thirty students, indicates that while all participants recognize the significance of civic action and participatory decision-making at both local/neighborhood and institutional levels, none had actively engaged in any form of social or political action – such as formal local government bodies, civic associations, grassroots initiatives, or university student unions. As articulated by the students, the primary drivers of this disengagement or reluctance to act were a profound distrust in formal decision-making channels and

governance structures, coupled with a pervasive conviction that individual and collective agency remains ineffectual. These insights – reflecting political apathy, institutional distrust, and a sense of futility – mirror common themes in everyday discourse and align with broader empirical research examining citizens' attitudes toward public administration [14, 10, 25]. Therefore, learning about participation seems exceptionally important within the university environment in which we operate, with the goal of strengthening students' 'capacity to aspire' [1] as well as encouraging and nurturing an 'ethics of possibility' [1] that integrates imagination, hope, and social action leading to the active shaping of the future.

Within the Urban Anthropology course, participatory processes in urban planning in Croatia are an important topic. Participation is a foundational value promoted across numerous global and European policy documents, such as *The New Urban Agenda* (UN Habitat, 2016) or *The New Leipzig Charter* (EU 2020). The former states, among other principles, that cities should provide inclusive platforms that "allow meaningful participation in decision-making, planning and follow-up processes for all" (NUA art. 41). Similarly, the latter emphasizes that "experimenting with new forms of participation can help cities manage conflicting interests, share responsibilities and find innovative solutions while also reshaping and maintaining urban spaces and forming new alliances to create integrated city spaces" (NLC, sec. C). Regarding urban spaces and built environment, this democratic imperative is formally operationalized through participatory planning – the systematic inclusion of citizens in planning and decision-making processes, which is legally regulated at both national and municipal levels.

In the Republic of Croatia, the *Physical Planning Act* prescribes the principle of public and civic participation in spatial planning (Art. 16). Alongside "expert discussions" with invited participants (public, private, economic, and other stakeholders) (Art. 118-120), there is a mandatory "public inspection" period during which the proposed spatial plan is accessible to the general public. During this period, a public hearing is conducted "in which everyone can participate", coupled with a requirement for a formal presentation by experts. This framework provides interested parties the opportunity to ask questions or submit written inquiries, allowing the public to voice "opinions, suggestions, and remarks" to which planning experts must respond (Art. 121-128). While this legal framework is respected, monitoring the processes of participatory planning reveals significant shortcomings: the lack of transparency in official procedures and the hermetic nature of technical, professional language frequently alienate citizens from planning process. Furthermore, positioning public/civic involvement at the very final stage of the planning process severely restricts the potential for effective citizen-led interventions, thereby demoralizing and disempowering the citizens.

According to the ladder of participation in spatial planning conceptualized by Sherry Arnstein in the late 1960s, the current model defined by Croatian legislation fluctuates between the levels of "non-participation" and "tokenism" (symbolic involvement) [2] and does not enable or create true citizen power. When analyzing participatory planning as a distinct niche of participatory governance, empirical research across various national contexts demonstrates that participation can also function as a mechanism of dominance and control. Specifically, it often excludes vulnerable and marginalized groups who face systemic barriers or lack access to information, formal communication channels, and political influence. Consequently, it is crucial to understand how participation "works, for whom, and with what social justice outcomes" [8, pp. 6-7]. This implies that a rigorous focus on asymmetrical power dynamics is essential both in the analytical evaluation of participatory processes and in their practical implementation, particularly when the objective is to cultivate the transformative potential that participation can possess [8].

Our insights to date, derived from ongoing research projects and observations of citizens' involvement in spatial planning, indicate that there is insufficient knowledge regarding how the city is organized, how spatial planning processes work, how broader public interests could be articulated, and what are the specific avenues available for civic engagement in shaping spatial policies. In a recent collaboration within the project PARTICIPARE we have reflected on the necessity of integrating participatory learning into university curricula as a means to empower youth for participatory planning. The underlying intention of the project is to enhance futures literacy through educational engagement with civic participation in urban planning.

Futures Literacy and Cultural Anthropology in Participatory Planning

The term Futures Literacy, coined by a futurist Riel Miller [16, 17] in the mid-2000s, emerged from the field of futures studies. Grounded in understanding anticipation as a "pervasive" feature of reality [19, p. 55], it emphasizes the human capacity to recognize and reflect on "anticipatory assumptions" that shape how futures are imagined and "used" [18, p. 49]. Its core premise is that rendering these assumptions

visible can enhance capacities for engaging uncertainty and crises. Since Futures Literacy is epistemologically aligned with foresight rather than forecast, this approach privileges open-ended and exploratory engagements with alternative futures [19, p. 56]. From 2012 onward, UNESCO adopted Futures Literacy as a core competence for the twenty-first century, framing "using-the-future" as a resource for learning and decision-making (https://www.unesco.org/en/futures-literacy). This institutionalization helped consolidate the concept through Futures Literacy Laboratories – participatory processes through which diverse actors collaborate in exploring anticipatory assumptions [5].
Recent interdisciplinary scholarship has called for a critical expansion of Futures Literacy beyond its dominant framing as a neutral competence. Marking a shift toward critical futures literacy as a reflexive, situated, and transformative "set of practices", it simultaneously opens space for recognizing diverse already existing futures literacies [6, p. 7]. A key move in futures literacies pedagogy is oriented toward the democratization and pluralization of how futures are imagined and enacted, through forms of education that cultivate responsibility for shaping more just societies [11, p. 58]. Building on these premises, critical futures literacy links futures thinking with critical pedagogy and epistemic justice, emphasizing the importance of shaping students' capacities to "question, co-create, and act" upon alternative futures [26, pp. 1, 3].
Despite overlapping concerns, there has been relatively little exchange between Futures Studies and social science and humanities approaches to the future [21, p. 6]. The anthropology of the future [20, 4, 9] offers one way of bridging this gap by expanding the framework of Futures Literacy and connecting it with critical pedagogical approaches. From this standpoint, the pedagogical task extends beyond making anticipatory assumptions visible to also identifying and analyzing the multiple and interconnected ways of relating to the future. Situated within cultural anthropology, this approach draws on its long-term fieldwork orientation, bottom-up perspective, and close collaboration with communities. Through its methodology, grounded in interviewing and participant observation, cultural anthropology offers well-developed ways of building relationships with communities and understanding their experiences and needs, which are central to participatory processes. This perspective could inform the PARTICIPARE project (as well as broader teaching practices and community-engaged initiatives), where futures literacy is cultivated within the social-service learning framework, through learning based on experience, research and engagement oriented toward socio-spatial transformation.
Within this framework, futures literacy operates on two interconnected levels. First, at the level of student education, it involves cultivating analytical sensibilities rather than transmitting standardized competencies. These include recognizing the future as one dimension of temporality, alongside past and present [22, p. 18]; understanding anticipation as only one among multiple relations to the future [1, 4]; and recognizing the coexistence of diverse *temporal* orientations and their relation to action [24]. Such preparation leads to a better understanding of why people engage (or do not engage) in efforts to transform their living environments. Moreover, it can provide tools for understanding how various relations to the future emerge, interact, and sometimes collapse in concrete social and spatial contexts, while foregrounding everyday practices and experiences, civic engagement, power relations, and inequalities in the complex processes of "future-making" [9, 23, 24]. Second, in community engagement, students are understood as participants in processes through which existing, situated futures literacies can be articulated, reflected upon and potentially reshaped. This implies shifting from teaching futures literacy toward supporting articulation of existing relations to the future and the forms of action linked to them. Such processes remain grounded in present material and social conditions, and attentive to questions of social, epistemic and spatial justice. Although anticipation remains only one among multiple relations to the future, it may become a particularly relevant mobilizing orientation in participatory process aimed at enabling community-driven change.
It may be concluded that cultural anthropological expansion of futures literacy lies in understanding futures literacy as a relational, situated and participatory practice grounded in empirical realities, temporal and affective relations, but also in uneven capacities to imagine and shape futures. This shift builds on calls for the democratization and pluralization of futures literacy [11], while grounding them in anthropological fieldwork and methodological practice. In this way, futures literacy is approached as an evolving methodological and pedagogical practice co-developed through research, collaboration and ongoing critical engagement.

Conclusion

Within the proposed service-learning project PARTICIPARE integrated into the Urban Anthropology course, diverse social actors will collaboratively address contemporary urban planning challenges. This cooperative framework enables participants to learn from one another while practicing democratic

processes and futures literacy, which should guide the participatory shaping of urban spaces in accordance with residents' needs and visions. The entire process of teaching, learning, and action is conceived as overlapping and complementary, yielding both tangible and intangible outcomes for local communities, students, and other stakeholders/participants in the process.

These objectives focus particularly on raising awareness about the importance of more permeable and accessible participatory processes, enhancing the recognition of civic voices in decision-making concerning their lived environments, and fostering more balanced power relations between institutions, experts, and local communities. Furthermore, the project aims to foster collaborative and participatory practices that support social inclusivity, civic engagement, and more just forms of shaping urban space. In this context, it seeks to strengthen the role, visibility and relevance of cultural anthropology in participatory urban planning by further advancing approaches that intersect research, education, and civic participation, while concurrently reinforcing transdisciplinary collaborations and promoting dialogue among the diverse actors involved in the co-creating of cities and futures.

Within this framework, the service-learning infrastructure enables futures literacy to function as a connective practice that bridges these different aspects by enabling the democratization of urban futures through the transformation of how futures are imagined and acted upon within present socio-spatial contexts. Additionally, such a participatory format for envisioning and collectively shaping urban public space would specifically serve as a model for development of participatory and educational practices, promoting decentralization, experiential learning, applied scholarship, social inclusivity, and the advancement of participatory governance practices.

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Youth Experience in Sport: A Case of Football Development Programs in Lithuania

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Abstract

Participation in organized sport is widely recognized as an important context that can support children and adolescent's health, positive development, and well-being. Football development programs, which involve the largest number of youths worldwide, also contribute to these educational and developmental outcomes through sport. However, survey-based measures that capture key aspects of youth experiences in organized sport have not yet been applied in Lithuanian sports education context. The aim of this study is to assess youth experience in football using Lithuanian versions of the adapted and validated Youth Experiences Survey for Sport (MYES-S) and four subscales from the Life Skills Scale for Sport – Transfer Scale (LSSS-TS). A total of 121 male athletes aged 14-15 participated in the study. Data were collected using the MYES-S and teamwork, emotional skills, time management and leadership skills subscales from LSSS-TS and the Coach-created Empowering and Disempowering Motivational Climate Questionnaire (EDMCQ-C). The current study provides support for the validity and reliability of the Lithuanian version of the MYES-S, as well as the validity and reliability of the Lithuanian version of four subscales from LSSS-TS. In addition, the study found that initiative (M = 3.49; SD = 0.46), personal and social skills (M = 3.27; SD = 0.51), and teamwork (M = 4.03; SD = 0.59) are the most prominent youth experiences acquired through sports. Meanwhile, cognitive skills are indicated as the least developed (M = 2.41; SD = 0.82). In addition, it was found that youth experiences in football are related to the motivational climate created by the coach.

Keywords: *Sport education, youth, personal experience*

1. Introduction

Children and adolescents' participation in sports activities is widely recognized as an important context that can support their health, positive development and well-being [1]. When this activity is implemented through sports education programs within the framework of non-formal education, the educational function of sports is particularly highlighted [2]. This means that organized sports education becomes an important part of the overall physical, emotional, social and psychological health of children and adolescents [3] , where the positive effect is achieved mainly through physical activity, an essential part of most sports [4]. Becoming a means to achieve the recommended level of physical activity, directly associated with a lower risk of cardiovascular diseases and metabolic disorders, better development of motor skills, normal or even stronger skeletal development [5], sports education also leads to better mental health [6], influences the system of values [7] and contributes to positive developmental outcomes. It ensures higher academic achievement, social adaptation, less antisocial behavior, the formation of stronger relationships and a positive peer network, a lower level of social and emotional problems [8,9], and contributes to cognitive, emotional, moral, social and identity development [10]. In other words, sports education of children and adolescents forms socially integrated and functional personalities, which is closely related to the theoretical paradigm of Positive Youth Development (PYD) in sports education. It is most often used to analyze how sports contribute to the holistic development of young people, their life skills development and emotional maturity by emphasizing strengths, not just sports results [11,12].

Despite the advantages and positive outcomes, organized youth sports also have negative educational consequences, such as injuries, aggression, selfishness, disrespect for others, burnout, depression, etc. [13,14]. And this is clearly associated with high-performance sports education programs, whose main goal remains the systematic development of sports results [15].

Football development programs are also highlighted in this negative context. It has been found that programs aimed at adolescents and dominating the number of sports participants in the world, when compared to programs aimed at children, focus much more attention on the development of sports performance excellence, physical and psychological preparation, thus aiming to prepare a highly skilled

football player. [16]. This situation is further exacerbated and made worse by the peculiar treatment of football as a “male sport”, which leads to the application of training models aimed at men and ignoring the needs of girls, which limits their involvement and positive experience [17]. However, scientific insights state that these sports education programs, despite the main goal of achieving sports results, can significantly contribute to the development of personality [18]. However, positive developmental outcomes are not guaranteed by participating in sports. Therefore, the need for continuous research is increasingly emphasized, which would allow us to understand how sports in a changing environment affect the health and development of youth [19].
Thus, although sports education can be a significant factor in positive youth development, its impact remains ambiguous as it depends on both the educational environment and the nature of the programs. Despite the growing international interest in youth experiences in sport, in the Lithuanian context there remains a lack of empirically grounded understanding of the real situation in sports education programs, especially in football. In view of this, the aim of this study is to assess youth experience in football using Lithuanian versions of the adapted and validated Youth Experiences Survey for Sport (MYES-S) and four subscales from the Life Skills Scale for Sport – Transfer Scale (LSSS-TS).

2. Methodology

A quantitative, cross-sectional research design was employed to examine youth sport experiences associated with positive developmental outcomes. The study involved participants from football development programs designed to nurture elite youth athletes. As only male players participate in the Lithuanian Cadets’ Football Championship (U13–U14 age group; https://jaunimofutbolas.lt/english), the research sample consisted of 121 male athletes (mean age = 14.49 years, SD = 0.50). Participants were selected using convenience sampling. Data were collected via paper-and-pencil questionnaires administered across several football academies.
The study was conducted in accordance with the Declaration of Helsinki and approved by the Research Ethics Board of the Lithuanian Sports University (Protocol No. SMTEK-43, 2025.04.18). Prior to data collection, informed consent was obtained from parents and/or legal guardians. Participants were informed about the purpose of the study, the instruments used, the research procedures, and their right to voluntarily participate and withdraw at any time.
A questionnaire survey employed several instruments described below. To assess the social environment of football development programs, the Coach-Created Empowering and Disempowering Motivational Climate Questionnaire (EDMCQ-C), adapted for use in Lithuania [20], was used. The questionnaire consists of 34 self-report items, divided into two subscales that assess empowering and disempowering motivational climates within the team. Items are rated on a 5-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Mean scores were calculated for each subscale.
Youth sport experiences were assessed using the Modified Youth Experiences Survey for Sport (MYES-S) [21] and four subscales from the Life Skills Scale for Sport – Transfer Scale (LSSS-TS) [22]. The MYES-S consists of 26 items assessing six dimensions: personal and social skills, cognitive skills, goal setting, initiative, physical and psychological health, and negative experiences. Items are rated on a 4-point Likert-type scale (1 = *not at all*, 4 = *yes*).
The LSSS-TS subscales assess life skills transferred through sport participation, including teamwork, emotional skills, time management, and leadership skills, and consist of 23 items. Responses are provided on a 5-point Likert scale (1 = *not at all*, 5 = *very much*).
Prior to data collection, all instruments assessing youth experience in sport underwent translation and cross-cultural adaptation in accordance with the *Guidelines for the Process of Cross-Cultural Adaptation of Self-Report Measures* [23]. This process involved five stages: (1) initial translation, (2) synthesis of translations, (3) back-translation, (4) expert committee review, and (5) pretesting of the final version.
To evaluate the psychometric properties confirmatory factor analysis (CFA) was conducted. Reliability was assessed using Cronbach’s alpha and McDonald’s omega, while construct validity was examined through composite reliability (CR) and average variance extracted (AVE). To examine external validity, the EDMCQ-C was used to assess its relationships with youth sport experience and life skills transfer constructs measured by the MYES-S and LSSS-TS.
All analyses were conducted using IBM SPSS Statistics and AMOS software.

3. Results and Discussion

In this study, football was chosen as the context due to its popularity, early specialization tendencies, and large number of participants. Considering this, this sport can be considered representative for analyzing youth sports development processes.
The sample for this study consisted of 121 male football players, aged 14 to 15 years. All study variables were normally distributed, and the values of asymmetry and kurtosis were within acceptable limits, indicating suitability for parametric analysis. Descriptive statistics and internal consistency indices of the instruments (MYES-S and LSSS-TS) are presented in Table 1.

Table 1. Descriptive statistics and reliability

Scale	Subscale	M	SD	α	ω
MYE-S	Personal and social skills	3.27	0.51	0.75	0.76
MYE-S	Cognitive skills	2.41	0.83	0.85	0.85
MYE-S	Goal setting	3.17	0.57	0.73	0.74
MYE-S	Initiative	3.49	0.46	0.74	0.76
MYE-S	Physical and psychological health	3.40	0.55	0.61	0.62
MYE-S	Negative experiences	1.53	0.56	0.89	0.87
LSSS-TS	Teamwork skills	4.03	0.59	0.81	0.80
LSSS-TS	Emotional skills	3.77	0.81	0.86	0.87
LSSS-TS	Time management skills	3.60	1.00	0.89	0.89
LSSS-TS	Leadership skills	3.72	0.80	0.90	0.90

M – Mean, SD – Standard Deviation, α – Cronbach's alpha, ω – McDonald's omega

The mean scores (min - 1, max - 4) on the MYE-S subscales ranged from 1.53 (SD = 0.56) for negative experiences to 3.49 (SD = 0.46) for initiative. Others, Personal and social skills (M = 3.27, SD = 0.51), goal setting (M = 3.17, SD = 0.57), and physical and psychological health (M = 3.40, SD = 0.55) also showed relatively high levels of positive developmental experiences, while cognitive skills showed lower scores (M = 2.41, SD = 0.83).
The mean scores (min - 1, max - 5) for the LSSS-TS subscales were: teamwork (M = 4.03, SD = 0.59), emotional skills (M = 3.77, SD = 0.81), time management (M = 3.60, SD = 1.00), and leadership (M = 3.72, SD = 0.80).
Internal consistency across all subscales was acceptable to good. Cronbach's alpha values for the MYE-S scale ranged from 0.61 to 0.89 (overall α = 0.87) and for the LSSS-TS subscales ranged from 0.81 to 0.90. McDonald's omega coefficients ranged from 0.74 to 0.90. The internal consistency of the subscale “Physical and psychological health“ was marginal but acceptable for research purposes.
An exploratory factor analysis (EFA) was conducted to examine the structure of the adapted instruments. The data were validated for factor analysis using the Kaiser-Meyer-Olkin (KMO) and Bartlett's test of sphericity ($\chi^2 = 2320$, $p < 0.001$). The KMO was 0.86.EFA was conducted using principal axis factoring with oblimin rotation.
The MYE-S data largely confirmed the original six-factor structure, although some overlap was observed among the dimensions of positive development. The items from the LSSS-TS clearly aligned with the four factors of the theoretical subscales. The extracted factors explained an adequate proportion of total variance.
Confirmatory factor analysis (CFA) was conducted separately for MYE-S and LSSS-TS. The results show that the six-factor MYE-S model fit the data well: $\chi^2(260) = 366.55$, $p < 0.001$; $\chi^2/df = 1.41$; CFI = 0.916; TLI = 0.903; RMSEA = 0.058. Meanwhile the four-factor LSSS-TS model fit the data acceptably: $\chi^2(244) = 370.80$, $p < 0.001$, $\chi^2/df = 1.66$, CFI = 0.90, TLI = 0.89, RMSEA = 0.074. The standardized factor loadings were statistically significant ($p < 0.001$), ranging from 0.39 to 0.92 for the MYE-S model and from 0.59 to 0.88 for the LSSS-TS model.

Convergent validity revealed that the composite reliability (CR) values of the MYE-S ranged from 0.61 (Physical and psychological health) to 0.90 (Negative experiences), and the average variance extracted (AVE) ranged from 0.35 (Physical and psychological health) to 0.60 (Negative experiences and cognitive skills). The CR values for the LSSS-TS ranged from 0.81 (teamwork) to 0.90 (leadership), and the AVE values ranged from 0.38 (Teamwork) to 0.68 (Time management). These results indicate acceptable convergent validity for most of the constructs.
The EDMCQ-C was not included in the validation procedures because the study used its previously validated Lithuanian version [20]. Instead, it was used to examine external relationships with the adapted measures.
Descriptive statistics showed that the empowering motivational climate created by the coach was rated higher by the subjects (M = 4.05, SD = 0.64) than the disempowering climate (M = 2.43, SD = 0.68). Internal consistency was high for both subscales (enabling: α = 0.91; disabling: α = 0.87). Pearson correlation coefficients between motivational climate and the validated constructs are presented in Table 2.

Table 2. Pearson correlations between motivational climate and study variables

Variable	1	2	3	4	5	6	7	8	9	10	11	12
1. Empowering climate	-											
2.Disempowering climate	-0.49**	-										
3. Personal and social skills	0.42**	-0.05	-									
4. Cognitive skills	0.21*	0.13	0.51**	-								
5. Goal setting	0.37**	-0.03	0.62**	0.53**	-							
6. Initiative	0.45**	-0.27**	0.40**	0.20*	0.55**	-						
7. Physical and psychological health	0.37**	-0.05	0.35**	0.29**	0.38**	0.49**	-					
8. Negative experiences	-0.25**	0.29**	-0.06	0.21*	-0.03	-0.24**	-0.12	-				
9. Teamwork	0.58**	-0.23*	0.62**	0.41**	0.52**	0.37**	0.34**	-0.12	-			
10. Emotional skills	0.36**	0.05	0.59**	0.37**	0.57**	0.48**	0.39**	-0.07	0.56**	-		
11. Time management	0.29**	0.04	0.61**	0.53**	0.64**	0.36**	0.29**	0.01	0.50**	0.58**	-	
12. Leadership	0.43**	0.01	0.69**	0.52**	0.66**	0.40**	0.34**	-0.03	0.63**	0.67**	0.70**	-

* p < .05, ** p < .01

The results of the study, after calculating the correlations between the variables, revealed that the empowering climate was positively correlated with the skills being developed, and the correlations ranged from low to strong (r = 0.21–0.58). Specifically, according to the MYE-S scale, the empowering climate showed a significant positive relationship with personal and social skills (r = 0.42, p < 0.01), cognitive skills (r = 0.21, p < 0.05), goal setting (r = 0.37, p < 0.01), initiative (r = 0.45, p < 0.01) and physical and psychological health (r = 0.37, p < 0.01). Similarly, the empowering climate was moderately to strongly correlated with the skills measured on the LSSS-TS scale, i.e. was moderately or strongly associated with teamwork (r = 0.58, p < 0.01), emotional skills (r = 0.36, p < 0.01), time management (r = 0.29, p < 0.01), and leadership (r = 0.43, p < 0.01). In contrast, the disempowering climate revealed weaker and less consistent associations with the developmental outcomes assessed. Negative associations were found with selected MYE-S and LSSS-TS scale variables, such as initiative (r = -0.27, p < 0.01) and teamwork (r = -0.23, p < 0.05). Meanwhile, correlations for other skills were insignificant.

The disempowering climate was found to be positively associated with negative experiences ($r = 0.29$, $p < 0.01$).
First, the acceptable reliability and factorial validity of the MYES-S scale and the selected LSSS-T scale subscales adapted in this study support previous evidence that youth development outcomes associated with positive development can be measured across cultural and social contexts [24]. Second, the results of the study revealed that adolescents participating in football education programs perceive that they gain positive experiences and develop a range of skills that are considered to be outcomes of positive youth development. This undoubtedly supports the positive impact of sport on adolescents found in other studies [11, 25]. And the high scores in the dimensions of initiative, personal and social skills and goal setting indicate that football education programs can be meaningful as a youth education context in which goals related to sports performance do not become essential. However, one should not ignore the fact that lower scores in the cognitive skills dimension may be associated with an orientation towards sports results, typical of elite youth football programs, where an orientation towards positive youth development is not a priority [26].
The study also revealed that an empowering motivational climate created by the coach has a positive relationship with both positive outcomes in sports education, which is consistent with research based on self-determination theory and positive youth development [27]. On the contrary, the established relationship between a coach's disempowering climate and negative experiences can be linked to the findings of other studies showing that a controlling, goal-oriented coach harms the well-being and development outcomes of the athlete [28].
Taken together, the results of this study confirm that positive developmental outcomes in youth sport are not guaranteed by participation in sports activities alone, but are largely determined by the social environment [11]. In summary, the results of the study highlight the role of coaches as key social agents in sports education, related to the formation of youth's football experience, and emphasize the importance of their behavior in practical activities.

Conclusion

This study provides empirical evidence that reveals the suitability of football education programs implemented in Lithuania as a context for positive youth development. However, appropriate motivational conditions should be created for this. The adapted Lithuanian versions of the MYES-S and selected LSSS- TS subscales were characterized by acceptable psychometric properties, confirming their use in assessing youth sports experience in the national context. The results revealed that the majority of young football players stated a high level of assessed skills, and indicated that they had relatively few negative experiences. Importantly, the results emphasized the key role of the motivational climate created by the coach, showing that an empowering climate was consistently associated with more positive experiences and was more conducive to the development of skills associated with positive youth development. In contrast, a disempowering climate was primarily associated with negative experiences in sports activities, i.e. playing football. These results confirmed theoretical insights that suggest that participation in sports does not guarantee positive developmental outcomes. Such results are highly dependent on the quality of the social and motivational environment. From a practical perspective, these research results highlight the need for coach education related to their behavior and the activities they implement. Further research should include athletes from different sports and genders in order to better understand the current situation and promote sustainable youth development through sport.

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From Displacement to Possibility: Teachers' Roles in Restoring Hope for Refugee Students

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Abstract

Refugees, unlike immigrants who relocate voluntarily, face challenges that are distinct and often severe. These include educating children who have endured sustained trauma, the loss of family members and social support networks, health vulnerabilities, and significant cultural and linguistic barriers. Global incidents have intensified the urgency for teachers, school leaders, and policymakers to be adequately prepared to serve refugee learners. While schools may function as safe spaces for many students, they can represent either a source of stability or an additional site of distress for refugee children. Globally, nearly 50 million children are refugees, and almost half remain out of school. For those who do access schooling, new difficulties emerge the moment they enter the classroom. This paper is anchored in the theme of restoring hope (Karkouti, Wolsey, & Toprak, 2019) to the context of schooling for refugees. This work explores how hope is lived, contested, and cultivated. Within this landscape, teachers confront significant challenges in responding to the diverse needs of refugee learners. Drawing on a case study framework, 20 high school teachers were interviewed, and the findings demonstrate the following themes: Teachers as Emotional First Responders; Language as Both Barrier and Resource; and Schooling as a Site of Either Hope or Harm. The paper concludes that there is a need for Reflective, Hope-Oriented Pedagogy. The findings suggest that refugee education in South African high schools is shaped more by systemic constraints and limited professional preparation than by teachers' willingness. The study positions teacher wellbeing and reflective practice as central to restoring hope and fostering inclusive, humane educational spaces.

Keywords: *refugees, displacement, teachers, restoring hope*

1. Introduction

"Without a minimum of hope, we cannot so much as start the struggle," (Paulo Freire, 1992).
The current global geopolitical landscape is defined by uncertainty, political strife, and rivalry between major world powers. As a result, those affected are forced to flee their countries, often at great personal cost. Consequences include translocality, or human relocation, and the need to rethink the spaces we occupy. Translocality refers to the way in which displaced populations become "regrounded…because of the new space of mobility" (Appadurai, 1996, as cited in [1} Zembylas, 2012, p. 165). A translocality, then, "is a space grounded in the daily lives, activities and social relationships of migrants" (Appadurai, 1996, as cited in Zembylas, 2012, p. 165). Migrants and refugees are often made to feel unwelcome in host countries, particularly in contexts of conflict. Educational organisations are obligated to address the needs of refugees and migrants and to mitigate the concerns and prejudices of local communities, yet little is known about how teachers may address these challenges. Since South Africa's transition to democracy in 1994, the influx of refugees has increased rapidly. African refugees in South Africa have become the new "other" and most likely occupy the lowest rungs of the new social order, facing severe issues of exclusion and marginalisation. When people arrive in a new country, the pressure to adapt is immediate. For children, this means attending school. For teachers, the responsibility of teaching children who have experienced sustained trauma—such as forced displacement, the possible loss of family members, the loss of social support networks, health challenges, and cultural and linguistic barriers—can seem insurmountable. While school can be a safe space for many students, for refugee learners, it can either provide a sense of stability or become a source of enduring distress. Nearly 50 million children worldwide are refugees, and almost half of them do not attend school [2](UNICEF press release, 2016). This growing crisis paints a bleak picture of the lives and circumstances of millions of children and their families affected by violent conflict and instability, often making perilous journeys seem safer than remaining in their home countries.
In this context, teachers face significant difficulties in responding to the diversity introduced by refugee learners. Social legacies of disempowerment and dehumanisation persist despite global efforts to

transition towards more socially just political orders. With human relocation occurring at unprecedented levels worldwide, it is imperative that educational organisations address the needs of refugees and migrants while also mitigating the concerns and prejudices of local communities.
Current educational settings in diverse societies often provide limited support for students from varied backgrounds. Preconceived notions about the cultures and identities of diverse communities, coupled with limited understanding of students' needs and traumas, may further marginalise them. This results in the creation of vulnerable student populations. What becomes evident is a "divide that exists between many educational institutions and the students they are supposed to serve" [3] (Paris & Alim, 2017, p. 95). This divide intensifies when students do not feel that their identities are affirmed in the curriculum; instead, they may perceive it as irrelevant, impractical, and exclusionary of their backgrounds, experiences, and lived realities.
These are the 'ethnoscapes' and 'translocalities' to which [4; 5] Appadurai (1990, 1996) refers. This is particularly relevant for refugee children; therefore, schools cannot disregard issues that contribute to classroom diversity. Such considerations are deeply embedded in social justice. The work of [6] Karkouti et al. (2019) with Syrian refugee children is instructive in this regard. Their findings reveal that teachers and administrators are primary providers of the social support children need to succeed academically. However, when such support is absent, children are likely to adopt coping strategies such as independence, perseverance, self-efficacy, and peer teaching. These findings are highly relevant for education systems and schools. Clearly, as teachers, we need to commit to more than just teaching content. The multiple complexities and disconnects related to language, culture, and identity—which contribute significantly to dehumanising practices in classrooms—require careful consideration.
[7] The South African Constitution (1996), [8] the Bill of Rights, and the [9] Refugees Act (1998) collectively protect the rights of all children in South Africa, including refugee children. All children are entitled to quality education. However, with the increasing number of refugee and migrant youth in South African schools, questions arise regarding how they experience these spaces, including the impact of language barriers, bureaucratic processes, and challenges related to cultural and social integration [10] (Harju, 2018). According to [11] Cerna (2019), refugee children are particularly vulnerable for two main reasons: forced displacement and the failure of education systems to adequately meet their needs. This undermines their potential for academic success, as well as their social and emotional well-being. My experiences as a researcher, teacher, and teacher educator have prompted me to explore how [12] Paulo Freire's (1970) critical pedagogy can deepen our understanding of teaching refugee learners. This article therefore examines how concerns about refugee children's experiences of schooling may be addressed through a pedagogy of hope, offering a framework for responding to these dissonances.

2. Theoretical Framework: Hope

Hope is the capacity to look beyond the present and imagine futures that do not yet exist. It is not neutral; rather, it is shaped by history, culture, and politics, as well as by the realities of race, class, and gender. In contemporary contexts, hope is a site of struggle. Yet it endures as a belief that new worlds can be created and that understanding across difference remains possible [13] (Mongane, 2025).
A 'pedagogy of hope' draws on the work of critical theorists such as [14] Paulo Freire, and [15] bell hooks. Freire emphasised hope as a critical dimension of teaching, enabling educators to confront dominant forces that disrupt lives and to work towards positive social change. In *Pedagogy of Hope: Reliving Pedagogy of the Oppressed* (1992), [14] Freire underscores that hope is essential for challenging oppression. In education, this requires critical consciousness and deliberate action to transform social realities. Hope is not passive; it demands engagement. Education must therefore be rooted in learners' histories and cultures, particularly in the case of refugee learners. A pedagogy of hope supports education for social change by addressing issues such as racism, xenophobia, and inequality, thereby contributing to the creation of inclusive societies.
Similarly, [15] hooks (2003) argues that inclusive communities generate hope through pedagogy [16] (Carolissen et al., 2011). She emphasises the importance of fostering inclusive spaces that challenge systems of oppression, encouraging teachers to move from critique towards active, hopeful, and democratic educational practices. For [18] Freire (1994), it is impossible to think about education without first acknowledging the power of hope. Hope is fundamental to human existence, and its educational implications are well established [17] (Webb, 2013). [16] Carolissen et al. (2011) suggest that a pedagogy of hope is grounded in both students' and teachers' awareness of themselves as practitioners and as human beings, particularly if education is to be non-threatening and anti-oppressive. Freire also highlights the importance of dialogic relationships between teachers and learners, where knowledge is co-constructed rather than imposed. Such interactions foster reflexivity, dialogue, and critical

engagement, enabling students to recognise both their own humanity and that of others, and to become critical citizens capable of effecting change within their communities.
[6] Karkouti et al.'s (2019) study, referenced earlier, explored Syrian refugee students' perceptions of the individuals who provide them with social support for academic success. Ten male Syrian eighth-grade students in a public middle school in Lebanon were interviewed. The participants expected teachers, supervisors, and administrators to offer such support; when it was lacking, they adopted coping strategies such as independence, perseverance, self-efficacy, and peer teaching. The perceived absence of support caused students to fluctuate between hope and hopelessness. Thus, the presence or absence of support directly influences experiences of hope or despair.

3. Research Design

This study adopts a qualitative approach, drawing on teacher narratives to generate data.

3.1 Narratives

Narratives are commonly used in qualitative research to elicit participants' stories and personal accounts of experience, "as told by them in their own words and worlds" [19] (Ntinda, 2020, p. 1), thereby placing people at the centre of research 20] [(Connolly & Clandinin, 1990). Narrative inquiry reflects how individuals experience the world, recognising that education and educational research involve the "construction and reconstruction of stories" (Connolly & Clandinin, 1990). Research on narratives is well established. [21] Hull and Katz (2006), for example, draw on [22] Ochs and Capps's (1996) work on personal storytelling to illustrate how narratives function as social practices. Their research with families from diverse backgrounds also demonstrates how children participate as co-storytellers.

3.2 Participants

The participants comprised 20 English teachers from high schools in Johannesburg. They were purposively selected, and all were enrolled in postgraduate education programmes at a university in Johannesburg.

3.3 Data Analysis

Narrative analysis was used to interpret the data. This approach involves examining stories shared within research contexts or everyday life. Researchers employing narrative analysis generate diverse yet meaningful interpretations by focusing on different elements within the stories.

4. Findings

The findings are presented across three themes: Teachers as Emotional First Responders; Language as Barrier and Resource; and Schooling as a Site of Hope or Harm.

4.1 Teachers as Emotional First Responders

Teachers consistently described their roles as extending beyond academic instruction, positioning themselves as emotional first responders to learners who have experienced trauma, displacement, and loss. Many participants reported encountering learners displaying anxiety, withdrawal, or aggression, often linked to past experiences of violence or instability. Such circumstances made teaching and learning particularly challenging.
P3 noted, "You can't just walk into the class and start teaching content. Some of them are carrying things we don't even fully understand. You first have to stabilise the child emotionally." Similarly, P7 explained, "Sometimes I feel like a counsellor more than a teacher. They come to you with stories—about losing parents, about moving from place to place." P11 added, "These are serious, damaging experiences; we cannot expect work to continue as normal."
This theme highlights the labour of care that teachers perform, often without formal training in trauma-informed pedagogy. While teachers expressed strong commitment, they also reported emotional fatigue. P1 reflected, "You want to help, but it becomes overwhelming because you are not trained for this." Emotional responsiveness is therefore central to teaching refugee learners, yet it remains under-recognised and insufficiently supported within formal schooling structures.

4.2 Language as Both Barrier and Resource

Language emerged as a complex and ambivalent factor in refugee education. Teachers identified language barriers—particularly for English First Additional Language learners—as a major obstacle to comprehension and participation.

P4 observed, “They struggle with the terminology. Even if they understand the concept in their own language, they can’t express it in English.” P8 noted, “Assessment becomes unfair because they know the work, but they can’t show it.” Teachers emphasised that learners who cannot engage in the language of instruction are significantly disadvantaged, making learning extremely difficult. However, teachers also recognised the potential of linguistic diversity as a resource. Some described using translanguaging strategies or encouraging peer support. P6 explained, “Sometimes I let them explain to each other in their own languages. You can see the understanding improve.” Translanguaging refers to hybrid language practices rather than strictly monolingual approaches. García (2009) describes it as the way bilingual and multilingual individuals draw on their full linguistic repertoires to make meaning and interact with the world. Greater accessibility to language can therefore enhance learning. Despite these efforts, teachers reported limited guidance on effectively integrating multilingual practices. While language is often framed as a deficit, it holds significant transformative potential when used strategically. This requires both professional development and systemic recognition of multilingualism as an asset.

4.3 Schooling as a Site of Hope or Harm

Teachers described schooling as a space that can either restore hope or reproduce harm for refugee learners. Positive experiences, characterized by inclusion, recognition, and support, were viewed as transformative.

P2 reflected, “When they feel safe and accepted, you can see the change. They start to believe in themselves again.” P6 added, “School can give them a sense of normality, something stable.” P11 stated, “School can be a safe space, given all these children have been through. We cannot make it stressful.”

Conversely, negative experiences such as exclusion, discrimination, or repeated academic failure can deepen feelings of alienation. P8 noted, “If they are constantly struggling or being left behind, school becomes another place where they feel they don’t belong.” P12 stated, “School can become additional stress, an unnecessary burden.”

This duality underscores the critical role of teachers and school environments in shaping refugee learners’ experiences. Hope is not inherent in schooling; rather, it is actively produced—or undermined—through everyday practices, relationships, and institutional structures.

4.4 Synthesis of Findings

Across all themes, a consistent pattern emerges: teachers demonstrate a strong willingness to support refugee learners, yet their efforts are constrained by systemic limitations, lack of training, and gaps between policy and practice. Restoring hope in refugee education therefore requires more than individual commitment; it demands structural change, sustained professional support, and pedagogical approaches that centre care, reflection, and inclusivity.

5. Conclusion

In conclusion, this study has shown that refugee education in South African high schools is shaped by a complex interplay of care, constraint, and possibility. While teachers demonstrate a strong ethical commitment to supporting refugee learners, often acting as emotional first responders and creating moments of inclusion and stability, their efforts are consistently limited by rigid curriculum demands, linguistic challenges, and uneven institutional support. The findings highlight that schooling is not inherently a site of hope, but one that can either enable belonging or reproduce marginalisation depending on how it is enacted. Central to addressing these tensions is the need for a reflective, hope-oriented pedagogy that recognises the emotional and professional labour of teachers, values multilingual resources, and is supported by coherent policy and targeted professional development. Ultimately, restoring hope in refugee education requires systemic shifts that move beyond individual teacher resilience towards more humane, responsive, and inclusive educational structures.

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Culture Shock: The Effect of School Culture on Teacher Burnout and Motivation during Polarizing Times

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Abstract

This research-based paper examines how school culture shapes teacher motivation and burnout during periods of heightened socio-political polarization. Schools increasingly function as microcosms of broader societal conflict, where debates surrounding race, gender, democracy, and public health enter classrooms and place new emotional and professional demands on teachers. Drawing on theories of motivation, burnout, and organizational culture, this qualitative study explores how teachers interpret and navigate these pressures through the lens of institutional alignment. Using critical incident methodology and semi-structured interviews with twelve teachers across three independent schools in the United States, the research identifies three distinct coping typologies: Insulators, who seek to shield themselves and students from external tensions; Activators, who engage societal conflicts as mission-aligned learning opportunities; and Gymnasts, who balance personal beliefs with institutional expectations. Findings reveal that perceived alignment between teachers' values and school leadership, policies, and mission significantly mediates experiences of burnout and motivation. When school culture functions as a coherent buffer—providing clarity, autonomy, and support—teachers report sustained engagement even during moments of societal rupture. Conversely, cultural misalignment amplifies isolation and emotional exhaustion. This study contributes to international conversations on teacher wellbeing, professional sustainability, and educational leadership by emphasizing the central role of school culture in navigating external pressures. Practical implications highlight the importance of mission-driven leadership, transparent communication, and professional autonomy in fostering resilient educational environments capable of supporting teachers in uncertain and contested times.

Keywords: *Education, society, burnout, motivation, politics, polarization*

1. Introduction

Over the past decade, U.S. citizens have endured a changing environmental climate, a pandemic, racial reckonings, insurrections, the overturn of Supreme Court rulings that were thought unassailable, financial bonanzas, and conversely, financial crises. Schools are microcosms of broader society and subject to any strife that the public feels. From natural disasters to political uprisings, schools field the concerns of their constituents. Rarely do outside concerns remain *outside*. Societal issues manifest in schools from the seemingly innocuous questions of children that ignite a culture war in the classroom to schools' policies on dress code that reify or accept gender and cultural norms. If there is a contested topic or major issue, that issue will find its way into classrooms and the daily dealings and interactions between teachers and students. While suicidal rates are on the rise domestically, they are also on the rise in individual schools [1]. While transgendered rights are debated, schools address antiquated bathroom systems with space for only two genders [2]. While the U.S. confronts racism, schools address student behaviors that mimic these racist tropes [3]. Teachers often are tasked with making sense of these crises to students. In this sense, the individual teacher faces the crushing weight of greater society if the school culture does not buttress and support the teacher's work. Additionally, a teacher who does not agree with a school's approach, mission, policies, and leadership will likely face frustration and greater levels of burnout. School leaders have no power to change society at a macro scale, but they do have the power to make the work of a teacher easier when confronting these challenges with students contributing to a mission-aligned culture.

The culture of the school is not divorced from the wider context of society, with phenomena from the national stage influencing a school's culture. This work examines the influences of all realms—the outer realm of society, the inner realm of a school's culture and context, and the most micro-realm focusing on the needs of individual teachers who face and make sense with students of these outer two realms [4]. This study argues that the school and its culture have the greatest impact on a teacher's sense of efficacy and motivation—the internal process that inspires a person to move toward a goal [5]. A teacher

who feels supported and culturally aligned with the broader school community will likely thrive despite any challenging influences from the broader realm of society. This study collects the narratives of teachers, all of whom have faced a challenging moment in their teaching, and records and analyzes their descriptions of these events, often commenting on the interplay between culture and motivation in the face of these events.
Increasingly, teachers are not contending with these issues in the abstract, but in concrete terms as these concerns manifest in schools directly. Ultimately, this is a study of what happens when a rupture that emanates from an outside fault line splits a school community affecting teacher motivation or conversely burnout levels. This work foregrounds the teachers who have borne the brunt of these challenges while examining the school culture that supported or hindered the teachers' efforts.

1.2 Research Questions

How do independent school teachers describe the ways which political tensions manifest in their work? What are the tensions, and how do they show up?

2. Theoretical Framework

This study applies theories of burnout, motivation, and organizational culture to examine teachers' experiences in the field of education during challenging societal times of extreme polarization. Drawing primarily from Herzberg's Motivation Theory [6], Maslach and Jackson's Burnout Theory [7], and Organizational Culture Theory [8], these frameworks situate teacher motivation and burnout not solely within individual psychology, but within the broader organizational and socio political contexts in which teachers work.
Herzberg's theory of motivation [6] still forms the basis of most contemporary theories and studies on the subject. Motivation, according to Herzberg, may come in many forms—pay, benefits, workplace regulations, etc.. Motivation also broadly speaks to why a teacher chooses to join the profession or why a teacher selects a particular school. Some teachers in this study are motivated by the freedom to design a curriculum free of the state standards found in other schools. In Herzberg's terms, this is motivating because of the autonomy it brings to teaching. The opposite, Burnout Theory [7] juxtaposes Herzberg's Motivation Theory. When examined in tandem—motivation and burnout—educational practitioners may discover some alarming trends of the teaching workforce. By addressing these trends, school leadership may retain teachers in the profession [9] and create motivated teachers who are more likely to inspire higher levels of student achievement [10].
More contemporarily, Dinham and Scott continue this work in the field of education with what they call the "third realm" of teacher satisfaction—the broader and larger macrosystems in which schools exist, going beyond just the immediate motivation of the workplace [4]. Dinham and Scott write that the third domain is "grounded in the wider environment surrounding the school, a domain which has grown in importance and influence and which teachers and school executives find uniformly dissatisfying." While day-to-day work associated with teaching brings educators joy, Dinham and Scott identify that what most dissatisfies or demotivates teachers is "largely out of the control of teachers and schools and found within the wider domain of society, governments, and the employing body." These "extrinsic societal and employer-based factors" cause a lack of motivation in teachers. This third realm houses the many factors that erode a teacher's satisfaction and cause a teacher ultimately to leave the profession. Throughout this study, readers will find Dinham and Scott's term of "third realm" with reference to society at large, and second realm and inner realm to mean the school and the individual teacher respectively. This study seeks to understand the relationship between the third realm—the realm of society—and the realm of school organizations and teachers, taking note of what actions school leaders may take to increase motivation (and decrease burnout) among teachers who feel the pressures of greater society.
This study also relies on theories of school culture coupled with notions of an individual's sense of motivation. Broadly, organizational culture presupposes "that the social context for work had a marked effect on the ways people approached their work, social relationships at work, and productivity" [11]. A teacher's placement within the social context of the school organization may evoke discord or harmony for that teacher. Culture provides a construct for how employees create a "shared meaning" of their organization derived from their experiences, the stories they hear, and the socialization process in their work setting [8].
The preceding theories set the stage for this study with the current state of U.S. affairs as the backdrop and ask if these theories are sufficient for the contemporary moment. Most importantly, this theoretical framework seeks to position schools as an institution within the broader socio-political landscape of the

nation by first examining the individual teachers, and then the culture of the school before venturing to the broadest realm of society.

3. Methodology and Research Design

This study commenced in the fall of 2023 with data collection, analysis, and review extending into 2025—past the influential U.S. Presidential election. I employed a phenomenological approach utilizing an emic perspective of teachers. The specific phenomenon examined was the experience of teaching in varying independent school settings during fractious times. I interpreted the results through a social constructivist framework, believing that knowledge is constructed through social interactions and the sharing of beliefs and practices.

I conducted this research by interviewing teachers at three independent schools that serve compulsory school-aged students in the Philadelphia area. Studies examining school-based phenomena such as culture, social-emotional learning, school models, and teacher efficacy commonly use three schools as the basis for conducting studies, citing three schools as a large enough sample to represent concerns found within a particular region [12].

My study focused on the perspective of 12 currently practicing educators (four teachers from each school site) who have remained in the field for a minimum of four years. This number represents roughly 10% of the teachers at each participating school or campus and mirrors participant totals found in several similar phenomenological studies centered on teachers' experiences [13]. Four teachers identified as "junior" with fewer than five years teaching while eight were tenured with more than a decade of experience. Teachers who entered the profession at least four years ago worked through the pandemic, the 2020 election, January 6th, Uvalde, and a number of other formative socio-political events.

Following participant selection, I interviewed teachers individually using semi-structured interviews to explore their experiences and the support they received in response to challenging socio-political events. Prior to the interview, I reviewed public-facing school documentation (i.e., mission statements and other documents available on school websites) to better understand the school's culture and therefore the context of the classroom experiences described. As part of the first interview, I read the school's mission statement aloud and asked whether the values expressed within it were practiced among the school's constituents.

I then used scenarios following the critical incident technique to illustrate examples of moments demonstrating how socio-political events test a school's ability to cope with such concerns. Definitionally, critical incidents are moments in one's career that test an individual's ability to cope with a situation using the skills, protocols, and knowledge available to that person [14]. These scenarios, based on race, socio-political events, gender, or identity politics, normalized discussion of challenging experiences and primed participants to consider similar incidents from their own schools. I concluded the first interview by asking participants to reflect on situations from their school to share during the next session. I allowed participants time between sessions to consider events and moments that may take time to remember or process. During the second meeting, we explored examples of similar situations from the participant's school.

The teachers also performed member checks, acting as a form of validity testing by bringing together educators from different schools to discuss their perceptions and review early findings. These group meetings created triangulation by allowing teachers from different organizations to share and compare their classroom experiences surrounding tense sociopolitical moments. The conversations were not intended to generate new data but rather to confirm or challenge my interpretations from earlier interviews.

Lastly, I continued validity testing by conducting a document review of mission statements and other school artifacts. For instance, a Friends school may process world events in accordance with egalitarian views found within its mission statement, whereas a Catholic school may approach such matters through different guiding beliefs. By contextualizing teachers' responses alongside the documents shaping their school environments, I added credibility to descriptions of the institutional culture surrounding these experiences.

I used an inductive method to code participant interviews, allowing themes and patterns to emerge from the data. Coding began with a provisional list of categories informed by my professional experience and by recurring themes in the literature surrounding motivation, burnout, and school culture. However, these early codes served only as an orienting framework rather than a predetermined structure imposed upon participants' experiences. Following the first round of interviews, I revised the coding list to reflect what actually appeared in the data. Codes that did not emerge in participants' narratives were removed, while

new codes were added to capture recurring but unanticipated ideas. For example, during the second round of coding, I found that explicit references to specific political parties or the 2024 election—topics I initially expected to surface—rarely appeared. Instead, teachers discussed broader concerns regarding polarization, identity, and institutional response without naming individual candidates or partisan positions. Likewise, while gender emerged as a significant topic, it primarily appeared through discussions of students' daily interactions rather than direct commentary on national political debates.
Similarly, I initially included several sub-codes related to compensation—salary, benefits, pay equity, and financial recognition—drawing from Herzberg's conception of "hygiene" factors [6]. However, compensation appeared only briefly in most interviews. This absence became a finding itself, suggesting that the sources of teacher burnout and motivation may have shifted since foundational studies on workplace motivation. Conversely, new categories emerged that I had not anticipated, particularly those related to mental health, counseling, and social media. Teachers described these themes as interconnected forces shaping both student experiences and their own professional motivation. Social media conflicts among students, for instance, frequently led to counseling interventions and classroom spillover that teachers were expected to manage.
To ensure the credibility and trustworthiness of the coding process, I engaged in several practices consistent with qualitative rigor. First, coding was iterative. After each interview cycle, I revisited both the raw data and the developing code list to confirm that the analytic categories accurately reflected participants' words. Second, I worked with a data partner who acted as a peer debriefer, helping identify blind spots and test whether coding decisions were grounded in the evidence rather than personal interpretation. We independently reviewed coded transcripts, compared patterns, and refined category definitions until agreement was reached. Third, I conducted member checks by sharing emerging typologies and code summaries with participants. These steps helped safeguard against researcher bias and reinforced the integrity of the analytic process.
It is important to note that the typologies presented in the following section were not predetermined or imposed upon the data. Rather, they emerged through iterative comparison of participants' narratives, recurring patterns, and points of contrast regarding how teachers navigated political tensions in their work. Initially, I observed distinctions between teachers who leaned toward open engagement with contentious topics and those who preferred preserving established norms or avoiding divisive issues. As analysis continued, however, additional responses surfaced that did not fit neatly within these emerging categories. The recognition of these outliers prompted deeper analytic reflection and eventually led to the identification of a third pattern that bridged aspects of the first two while introducing distinct behaviors and rationales of its own.
Once these patterns appeared stable and sufficiently distinct, I synthesized them into the typologies described in the findings. These typologies were treated as interpretive tools rather than definitive labels. They were intended to illustrate the range of teacher responses observed in the data rather than constrain them. Their formation was guided by the evidence and refined through peer review and participant validation. In this way, the coding process reflected the iterative, inductive, and reflexive nature of qualitative inquiry, privileging participant voice and allowing theoretical insight to emerge organically from their descriptions.

4. Findings

The following section shares findings from the study, analyzing the responses of 12 participants from three schools in the Philadelphia metropolitan area. The participants describe socio-political tensions they witnessed in the classroom, noting major themes of race, gender, identity, and global events such as the conflict in Israel and Gaza and the murder of George Floyd. In each case, a precipitating world event sparks a reaction at the local school level among students, faculty, and staff. Every participant's reaction could be categorized resembling elements of one of three themes, typologies, or coping patterns. Two participants exhibited characteristics spanning multiple typologies, suggesting that these categories function as interpretive tendancies rather than rigid classifications.

4.1 Description of Participants and Schools

Three schools participated in this study, representing three types or models of schools commonly found in eastern Pennsylvania independent schools— a Catholic girls' school serving grades 6-12, a Montessori school serving infants through grade 6, and a Friends' school associated with Quaker values serving early childhood through grade 12. All three schools are geographically near one another, spanning from Philadelphia to the Main Line, an affluent suburb outside of Philadelphia. All three schools

draw students both from within Philadelphia city limits as well as from the Main Line and other suburban areas. Additionally, all three independent schools enroll a predominantly white population of students. Nine of the 12 teacher participants identify as White female, matching national averages of teachers [15]. In this study, four teacher participants from each school shared their experiences, noting how various socio-political tensions have shaped their recent work.
Every teacher who participated in the study reported supporting their school's mission statement and what it represents. In each case, the mission statement contained key words to the organization or philosophy of the school (i.e. Catholic, Montessori, or a reference to Quaker values). In each case, a teacher shared that other members of the community may not be equally mission-aligned or might emphasize a different aspect of the mission statement. All participants viewed the mission statement as a guiding principle or a "differentiator" from other schools in the area. Furthermore, they felt the tension of when their school embodied the tenets of the mission statement or when they perceived that the basic principles of the mission statement were ignored.

4.2 Reaction to Critical Incident and Personal Critical Incidents

Critical incidents served the purpose to aid in research centered on "people's subjective impressions of organizational life, and the stories they construct in order to make sense of the environment in which they work" [14], by responding to a scenario and then sharing their own. These represented real events that the teachers had confronted during their teaching practice. Teachers often shared more than one critical incident. The topics included race, gender, and global events (with specific mention to conflict in the Middle East or the murder of George Floyd) as presented in Table 1.

Table 1.
Topics of Personal Critical Incidents

Topic	Times Shared
Race	11
Gender	3
Specific Socio-Political Event	9
Conflict in Middle East	3
Murder of George Floyd	6

Each of the participants' reaction to their experience can broadly be categorized in one of three thematic ways, creating typologies for the teachers: the Insulators, the Activators, and the Gymnasts.

4.3 The Insulators

Insulators represent teachers who strive to protect the established social order of their respective school and often have worked there for decades. They are not necessarily opposed to social or cultural changes within their school; however, they struggle with some aspect of socio-political tensions appearing in the classroom. Often during the interviews, the Insulators expressed yearning for the past, how the school used to be, while also recognizing that some change is good or necessary. They feel that conversations about socio-political or identity-based concerns is at best a distraction from the learning in the classroom or inappropriate or irrelevant at worst. Teachers that embody the Insulator theme often believe that it is not the work of the school to address issues as they arise in the world or contemporary society. They see these conversations as something inappropriate to discuss among children, something for parents to discuss with their own children at home, or altogether irrelevant to the lives of children. These teachers take umbrage with professional development that focuses on introspection or anything that evokes shame in them.
The teachers who belong to this category believe that schools are not porous, but rather that they have strong buffers protecting the students and school culture from the influences of outside culture. Contrarily, participants from the later sections (Activators and Gymnasts) believe the opposite that schools are porous to the influences of the outside world.

4.4 The Activators

Activators think schools are porous to outside events and accept that the tensions of the world will be felt within schools; however, these teachers hope that they can guide students through the lens of whatever mission the school holds (a Quaker, Catholic, or progressive lens). Activators see teaching as

a means of igniting change and raising the next generation with progressive values. Ultimately, they want their students to be aware, just, and progressive; leaders who are ready to bring about positive and liberal change for the world.
Activators are firmly anchored to their faith or school's philosophy, which is also deeply entrenched in their schools' mission statements. Their commitment to the school's mission, almost to a zealous manner, guides them through any crisis. School mission keeps them from drifting in their values and in some ways more committed to the institutional goals than even the school leadership who may have to appease a broader swath of the constituency. Activators mentioned elements of burnout, the challenges of the work and the frustrations of facing these tensions so regularly, as well as motivation, the desire to effect real change and serve a community in crisis. They have high hopes for their schools to serve the students in the manner presented by the schools' mission statements, and they are there to implement progressive teaching techniques, protect students' identities, and challenge authority when needed to make this happen.

4.5 The Gymnasts

Gymnasts exemplify teachers who acculturate to the organization, metaphorically bending over backwards to fit in. These participants find themselves at odds with their institutional culture or goals, while also performing acts that do not align with their personal beliefs. In each case, the independent school was a predominantly White institution that culturally or in some manner upheld the values associated with White, heterosexual, abelist, patriarchal culture. These teachers seem to perform mental gymnastics, overcoming what, as an outsider, appears to be cognitive dissonance to support their school and its implicit values. This type of acculturation requires a level of cognitive gymnastics to make two seemingly contrary principles coherent. In the case of all the participants, there was something redeeming about their organization that drew them. Whether they described their independent school as "like home," "comfortable," or "a place where [they wanted their] children to be," there was something about the institution that pulled them in and felt comfortable. They may believe they are part of "the fight to bring about change," or their actions may be deeply culturally or personally ingrained, and they are acting in the manner they believe is expected of them. Equally, there was something that felt like these teachers must reconcile– something with which they were at odds and had to remedy through logic and a compromise of their beliefs. These are the individuals that face the greatest possible harm or trauma because their identity is regularly not acknowledged. These practitioners exercise great perseverance in a system not rewarding of their work or always certain or supportive of their identity.

5. In Conclusion

Traditional frameworks for understanding burnout and motivation have largely focused on compensation, autonomy, and management. While these factors are undeniably important, they do not fully capture the complexities of teaching in today's highly politicized and socially charged environment. Current models of motivation and burnout fail to account for the emotional and psychological toll of navigating sociopolitical tensions in the classroom. Today's educators require a framework that acknowledges not just institutional factors, but also the broader cultural, political, and ideological landscape that shapes their daily work. As schools continue to navigate contentious political climates, rethinking how burnout and motivation are defined is essential to ensuring that teachers feel both supported and empowered in their roles. As schools become increasingly politicized spaces, the need for empirical studies exploring how institutional culture, community expectations, and national discourse impact teachers has only grown more urgent. Expanding the scope of research to include a more diverse sample of schools, geographic regions, and disciplinary fields would provide greater insight into whether the three identified typologies are universal or if additional typologies emerge in larger-scale studies.
These categories—the Insulators, Activators, and Gymnasts—offer a useful framework for understanding the ways teachers navigate political and cultural tensions in their professional lives. These typologies should not be seen as rigid or reductive classifications. Rather, they serve as a heuristic tool, a way to conceptualize the different approaches, challenges, and coping mechanisms teachers employ when faced with politically sensitive issues. Each individual teacher brings a unique perspective, but the presence of these typologies across all participating schools suggests that they may be applicable beyond this specific study, across different educational contexts.
For school administrators and policymakers, these themes hold significant practical implications, particularly when considering how to support faculty in politically complex times. Recognizing the presence of Insulators, Activators, and Gymnasts within a school community can inform strategies for

professional development, teacher engagement, institutional messaging, and school culture initiatives. Additionally, understanding these typologies can help administrators identify sources of burnout and create targeted retention strategies, particularly for Gymnasts, who often experience the greatest emotional strain as they attempt to reconcile personal values with institutional expectations.

Ultimately, teachers in this study described moments when external political events entered their daily practice of educating students. Questions of race, gender, religion, and national identity surfaced in lessons, in hallway exchanges, and in conversations with parents. In this sense, schools functioned as microcosms of the national dialogue, reproducing the same divisions and anxieties that characterize the public at large. These moments required teachers to draw upon their personal values while simultaneously navigating the expectations of their school's mission and leadership. The tension that emerged was not simply between individual and institution, but between the broader social climate and the educational environment charged with interpreting it. Teachers who perceived alignment between their personal commitments and their school's mission reported stronger motivation and purpose, while misalignment contributed to uncertainty, isolation, and burnout. When alignment exists, teachers experience affirmation and clarity of purpose. When it falters, teachers face moral and emotional dissonance that can erode their sense of vocation and purpose, demonstrating that motivation is not a fixed personal trait but a dynamic condition shaped by the relationship between the teacher and the institution.

The events of recent years—pandemic recovery, political unrest, racial reckonings, and renewed debates over gender and identity—have intensified these dynamics. Teachers have become interlocutors of the national conscience, often expected to mediate conflicts that the larger society has failed to resolve. For school leaders, this reality underscores the importance of transparent communication, mission clarity, and professional development that equips educators to approach contested issues with confidence. A school culture grounded in trust allows teachers to interpret these moments not as threats to stability but as opportunities for meaningful dialogue and growth.

The findings of this study suggest that motivation in teaching cannot be understood apart from the socio-political context in which teachers work. While traditional theories of motivation and burnout capture the internal dynamics of satisfaction and exhaustion, they do not fully account for the external pressures that now define the teacher's role. Future research must therefore continue to revisit these theories in light of evolving political realities, recognizing that what sustains teachers today may differ from what sustained them in earlier eras.

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Teaching Digital Inclusion Early: Practical Approaches to Accessibility in Primary Education

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Abstract

Digital technologies increasingly shape how learners communicate, learn, and participate in civic life. However, when digital content is created without attention to accessibility, it can unintentionally exclude individuals with visual, cognitive, or physical disabilities. As schools prepare young people for a digitally connected future, accessibility must be understood as a foundational digital literacy rather than an optional or specialist skill [1]. This imperative is reinforced by the European Accessibility Act [2]. Education therefore has a critical role to play in embedding inclusive design principles early. This paper reports on work completed to date within SEED: Supporting Equity and Educational Design: Growing Awareness of Accessibility in Digital Classrooms in Ireland's Primary Schools*, a Research Ireland–funded project examining current practices and awareness of accessibility in Irish primary education.*

Keywords: *Digital accessibility; inclusive design; primary education; digital literacy;*

1. Introduction

Digital technologies increasingly shape how learners communicate, learn, and participate in civic life. However, when digital content is created without attention to accessibility, it can inadvertently exclude individuals with visual, cognitive, or physical disabilities. As schools prepare young people for a digitally connected future, accessibility must be recognised as a foundational component of digital literacy rather than an optional or specialist skill. This imperative is further reinforced by policy developments such as the European Accessibility Act, which highlights the need for accessible digital environments across sectors, including education. Education therefore has a critical role in embedding inclusive design principles from an early stage. Recent discussions surrounding young people's engagement with digital technologies have frequently framed technology use primarily in terms of risk and overuse. However, emerging research argues that such perspectives often fail to distinguish between passive or recreational engagement and structured, educational, and purpose-driven uses of digital technologies. It is important to emphasise the importance of avoiding "one-size-fits-all" approaches to youth digital engagement and instead advocate for guided, literacy-based participation supported through education and policy initiatives. Within this context, accessibility education represents a meaningful form of digital engagement in which learners actively develop awareness of inclusion, usability, and equitable participation in digital environments [3]. When accessibility principles are applied, digital content becomes clearer, more flexible, and more usable for all learners [4]. Developing awareness of accessibility in primary school not only supports learners with diverse needs, but also fosters inclusive mindsets and practices among all pupils. Despite this, accessibility is not yet consistently integrated into everyday classroom activities, and there remains a limited availability of accessible, affordable classroom materials that explicitly support the teaching of inclusive design principles.

This paper reports on work undertaken to date within *SEED: Supporting Equity and Educational Design: Growing Awareness of Accessibility in Digital Classrooms in Ireland's Primary Schools*, a Research Ireland–funded project examining current practices and awareness of accessibility in Irish primary education. The project investigates how accessibility is currently addressed in classrooms and identifies gaps in teacher knowledge and available resources. In Ireland there are varying levels of digital engagement across primary classrooms and while there is some structured support for teaching accessibility concepts as part of routine digital learning there are few dedicated hardcopy classroom materials. The SEED project seeks to develop practical, curriculum-aligned resources to support teachers in introducing accessibility in meaningful and age-appropriate ways. The following sections outline the project context, methodology, preliminary findings, and the development and pilot implementation of a classroom-based accessibility toolkit.

2. Background and Context

Accessibility is increasingly recognised as a core dimension of digital literacy, encompassing the ability to create and engage with digital content that is usable by diverse audiences. Within educational contexts, this extends beyond technical compliance to include an understanding of inclusive design principles such as readability, colour contrast, and multimodal representation [4]. Approaches informed by Universal Design for Learning (UDL) emphasise proactive design that supports a wide range of learners, rather than retrofitting content to meet individual needs. Policy frameworks at both European and international levels further reinforce the importance of accessibility in education. The European Accessibility Act establishes requirements for accessible digital products and services, while the United Nations Sustainable Development Goals, particularly SDG 4 (Quality Education) and SDG 10 (Reduced Inequalities), emphasise inclusive and equitable access to learning opportunities. Together, these frameworks position accessibility as a shared responsibility across sectors, including schools. Despite this policy and theoretical emphasis, the integration of accessibility into everyday classroom practice remains uneven. Research indicates that while digital technologies are widely used in primary education, explicit attention to accessibility is often limited with relatively few dedicated resources available to support its teaching.

3. Seed Project Toolkit Development

In response to the gaps identified in preliminary findings, the SEED project developed a practical, classroom-based toolkit designed to introduce accessibility concepts to primary school learners in an engaging and age-appropriate manner. The toolkit was created to support teachers in embedding accessibility within existing classroom activities, particularly in the context of digital content creation tasks commonly undertaken by pupils in the senior years of primary school.

3.1 Posters

The toolkit comprises two large-format (A1) posters and a hardcopy learning resource in the form of a foldable cube. The posters were designed in accordance with established principles of document and communication design, drawing on seminal work such as Schriver's *Dynamics in Document Design*, which emphasises a reader-centred, evidence-based approach to the integration of text and visuals [5,6]. In addition, guidance from the National Disability Authority in Ireland informed the application of universal design and accessibility principles, ensuring that the materials are usable, understandable, and inclusive for a wide range of audiences [7]. The posters are printed on fabric to enhance durability and sustainability, and to enable their continued use within classroom settings as visual prompts for discussion. At the centre of the poster design is a thematic focus on hedgehogs, selected as an accessible and engaging narrative device and introduced in alignment with Ireland's Hedgehog Week. The poster design was also intentionally based on the native Irish hedgehog, as this species is incorporated within the Green-Schools biodiversity programme and highlighted as a "Habitat Hero", ensuring alignment with existing classroom resources, while the decision to print the poster on fabric further reinforces the sustainability principles underpinning the Green-Schools initiative [8].
Each classroom is provided with two contrasting posters: one intentionally designed to demonstrate poor accessibility practice, incorporating common design errors, and a second illustrating accessible and inclusive design principles. This contrast-based approach supports critical discussion and encourages learners to identify and reflect on design choices. While the posters were designed by a researcher with professional experience in accessible communication, care was taken to avoid an overly polished or complex aesthetic. Highly stylised or technically sophisticated designs, while visually appealing, may risk overwhelming learners in the senior years of primary school and can appear difficult to replicate. Instead, the posters deliberately model good accessibility practices in a way that remains achievable for pupils. By balancing adherence to core design principles with a level of visual simplicity, the materials aim to support not only understanding but also application, encouraging learners to view accessible design as something within their own capability rather than as a specialised or unattainable skill.

3.2 Cube

Complementing the posters, each student is provided with a flat-pack cardboard cube that can be assembled into a three-dimensional object. Each face of the cube presents concise, child-friendly design

guidance relating to digital content creation. These guidelines include principles such as clear text use, colour contrast, effective use of images, and accessible audio and video practices. For example, the cube encourages pupils to “use short sentences and simple words” and to ensure that “text colour is easy to see on the background,” while also promoting inclusive practices such as adding subtitles to videos and describing images for clarity.

3.3 Teacher Supports

To further support teachers in mediating classroom discussions, the toolkit also includes a compact, teacher-focused resource in the form of a keyring comprising eight concise reference cards. Each card highlights a specific design principle and provides a brief explanation of its importance in relation to accessibility and effective communication. For example, individual cards explain the rationale behind design decisions such as font choice, emphasising readability and clarity, or the use of appropriate colour contrast to ensure visibility for all learners. This resource is intended as a practical, easily accessible prompt to support teachers in reinforcing key concepts during classroom activities. Together, these elements extend the functionality of the toolkit beyond static visual materials, providing both learners and teachers with structured, accessible guidance. The combination of whole-class visual artefacts (posters), individual interactive materials (cube), and teacher supports (keyring cards) reflects a multi-layered pedagogical approach that accommodates different modes of engagement and reinforces accessibility principles through both exploration and guided instruction.

3.4 Emergent Elements in Toolkit Development

An unanticipated development within the project was the creation of an Irish-language version of the student cube. While not originally planned within the initial funding proposal, informal engagement with participating teachers highlighted the value of providing resources that align with Irish-language teaching contexts. In response, the content of the cube was professionally translated into Irish, enabling its use in both English- and Irish-medium classrooms. This adaptation reflects the project’s responsiveness to practitioner input and supports broader inclusivity within the Irish primary education system.

A further factor shaping the development of the toolkit was an industry partnership that emerged during the early stages of the project. Following the award of funding, engagement with Brickfield Education Labs at a professional conference provided access to an existing presentation design resource used in adult training contexts. With permission from the organisation, the project team was able to adapt the cube template for use in primary education settings. This significantly accelerated the development process and enabled the production of high-quality classroom materials within the constraints of the project budget. It also ensured that the design guidance embedded within the cube was informed by established industry practice in accessible digital communication. The collaboration illustrates the value of cross-sector partnerships in supporting the translation of accessibility principles into practical, scalable educational resources.

The focus on presentation design reflects a growing classroom practice, where pupils are frequently required to create digital presentations as part of their learning. While instruction is often provided on content and structure (e.g., number of slides or topics to include), there is typically limited emphasis on visual design principles or accessibility considerations. The toolkit therefore seeks to address this gap by embedding foundational accessibility guidance into familiar learning tasks, enabling pupils to apply inclusive design principles in a practical and meaningful way.

4. Discussion

At the time of writing, the classroom toolkit is in the early stages of implementation, and formal evaluation data has not yet been collected. Initial engagement has focused on consultation with participating school principals to introduce the project and its resources. These preliminary discussions were highly positive, with principals expressing strong support for the initiative and recognising the relevance of accessibility within contemporary digital learning contexts. Particular appreciation was noted for the quality and durability of the printed materials, as well as the provision of additional classroom resources to support teaching and learning. This initial response suggests that the toolkit aligns well with school priorities and is perceived as both practical and valuable for classroom use.

The toolkit is currently being implemented in participating classrooms, with data collection planned following a period of use within the upcoming school term. This will include teacher feedback on usability, clarity, and perceived impact, and will inform further refinement of the resources. As such, the present

paper reports on the design and early-stage deployment of the toolkit, with full evaluation findings to be reported in subsequent work.

5. Conclusion

This paper has highlighted the importance of positioning digital accessibility as a foundational element of digital literacy within primary education. Through the SEED project, it identifies a clear gap between high levels of digital engagement in classrooms and the limited availability of accessible, affordable classroom materials that explicitly support the teaching of inclusive design principles. In response, the development of a practical, classroom-based toolkit demonstrates how accessibility concepts can be embedded meaningfully within existing curricular activities. While formal evaluation is ongoing, early engagement with schools indicates strong interest in and relevance of the approach. The project contributes to ongoing efforts to support inclusive education by providing scalable, contextually relevant resources and by emphasising the role of early intervention in fostering accessible digital practices.

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Voices Against Violence: Community-Based Interventions for VAWC Prevention

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Abstract

The study investigated the demographic characteristics, knowledge, attitudes, and practices (KAP) of Anti-VAWC community champions, while also evaluating the efficacy of interventions executed in Ragay, Camarines Sur. The study detailed the respondents' demographic attributes, assessed their knowledge, attitudes, and practices concerning violence against women and children (VAWC), identified current interventions, analyzed the correlations among demographic profiles, KAP, and the intervention types, and ultimately suggested enhanced, gender-responsive programs.

The research utilized a descriptive-correlational design, incorporating a mixed-methods methodology. Quantitative data was obtained via structured survey questionnaires, which were distributed to a purposive sample of Anti-VAWC advocates - barangay officials, VAWC desk officers, law enforcement personnel, educators, and social workers. Qualitative data were collected through open-ended responses and subsequently analyzed using thematic analysis. The results indicated that the majority of respondents were female, belonged to the productive age bracket, and possessed a college education.

Knowledge regarding Violence Against Women and Children (VAWC) was assessed at a high to very high level, and attitudes were notably positive, indicating a robust awareness of gender issues and a dedication to safeguarding survivors. Practices demonstrated a certain degree of consistency, particularly in the areas of awareness campaigns, collaborative endeavors, and record maintenance; however, monitoring and follow-up protocols were identified as areas requiring improvement. Community-driven interventions were viewed as beneficial, particularly in fostering awareness and engagement, whereas monitoring systems demonstrated moderate efficacy. Statistical analyses revealed a significant relationship between demographic factors and knowledge, attitudes, and practices (KAP). Additionally, a strong positive connection was found between KAP and the specific interventions used.

Based on the Social Ecological Model, the study concluded that both individual skills and institutional structures influence how well interventions work. A sustainable, community-based approach was suggested to improve monitoring, strengthen referral systems, and enhance gender-sensitive Anti-VAWC programs.

Keywords: *Violence Against Women and Children (VAWC), community-based interventions, knowledge attitudes and practices (KAP), gender-based violence, Social Ecological Model, Philippines*

Introduction

Violence against women and their children (VAWC) remains a significant human rights and public health concern. Despite the implementation of Republic Act No. 9262, the Anti-Violence Against Women and Their Children Act of 2004 in the Philippines, occurrences of intimate partner violence, psychological abuse, economic abuse, and child maltreatment continue to be reported in various communities. Although legal structures are essential, successful prevention and intervention require sustained, community-based engagement that transcends formal judicial procedures.

Mirroring the situation in many rural municipalities, Ragay, Camarines Sur, relies on barangay-level structures, including VAWC Desk Officers, Women and Children Protection Desks (WCPD), the Municipal Social Welfare and Development Office (MSWDO), health units, and school-based advocates. The efficacy of these interventions is significantly influenced by the knowledge, attitudes, and practices (KAP) of both community advocates and institutional actors.

This study, based on the Social Ecological Model (Heise, 1998; CDC, 2022) and Social Learning Theory, suggests that Violence Against Women and Children (VAWC) is affected by various ecological levels. These levels include individual beliefs, relationships with others, and community norms, as well as larger

institutional and societal structures. Hence, prevention strategies should be multi-sectoral, gender responsive, and community driven.
Given the persistent issues of preventing and addressing VAWC on the ground, this study aims to produce empirical response evidence for successful community-based intervention in Ragay, Camarines Sur. This study specifically aims to assess the demographic characteristics and the Knowledge, Attitude, and Practices (KAP) of Anti-VAWC advocates. It will also examine how these factors affect the interventions used in their barangays and institutions. By combining quantitative data with qualitative information, the research seeks to identify institutional strengths, weaknesses, and areas for improvement. This will help to strengthen gender-responsive systems. Ultimately, the goal is to develop a sustainable, community-led Anti-VAWC framework. This framework will support referral systems, advocacy strategies, and participatory governance at the local level. Therefore, this will contribute to greater social justice, gender equality, and the empowerment of communities.

Methodology

This study utilized a descriptive-correlational design with a mixed-methods approach among 102 Anti-VAWC advocates who were purposively selected, including barangay officials, law enforcement personnel, educators, and social workers. Data were collected quantitatively using a self-made survey questionnaire, validated using a Likert scale with five sections: (1) demographic profile (2) Knowledge, Attitudes, and Practices (KAP) (3) Attitudes Toward VAWC (4) Practices in Anti VAWC Intervention and (5) Nature of Community Based Interventions. A pilot test was conducted with a minimum of 30 participants, succeeded by the computation of Cronbach's alpha to evaluate internal consistency. Qualitative data were gathered via focus group discussions (FGDs) and key informant interviews (KIIs) to gain a more comprehensive understanding of institutional coordination, referral mechanisms, implementation challenges, and sustainability practices. Descriptive statistics such as frequency, percentage, mean, and standard deviation were used to analyze quantitative data in order to assess levels of knowledge, attitudes, and practices. The relationships among demographic variables, KAP scores, and the type of interventions were analyzed using inferential statistics, like Pearson's r or Spearman's rho correlation analysis. The qualitative data from the interviews and focus group discussions were transcribed and thematically analyzed to identify recurrent themes of barriers between institutions, strengths in coordination, and possible avenues for improvement as a system. To improve validity and credibility of findings, including comparing quantitative

Results and Discussion

Quantitative Findings

The subsequent table elucidates the study's findings concerning community-based Anti-VAWC interventions within Ragay, Camarines Sur.

Table 1. Demographic Profile of Anti-VAWC Advocates in Ragay, Camarines Sur (n = 102)

Variable	*Category*	*Frequency*	*Percentage*
Age	26–35	34	33.33%
	36–45	38	37.25%
	46–55	16	15.69%
	56–65	12	11.76%
	66+	2	1.96%
Sex	Female	82	80.39%
	Male	18	17.65%
	Prefer not to say	2	1.96%
Civil Status	Married	66	64.71%
	Single	22	21.57%
	Others	14	13.72%
Educational Attainment	College	60	58.82%
	High School	20	19.61%
	Master's Degree	16	15.69%
	Doctorate	4	3.92%
	Others	2	1.96%

Table 2. Level of Knowledge on Violence Against Women and Children (VAWC) Among Respondents

Indicator	*Mean*	*Interpretation*
RA 9262 coverage	4.52	Very High Knowledge
BPO issuance	4.18	High Knowledge
Psychological violence	4.21	High Knowledge
Economic abuse	4.15	High Knowledge
First response protocol	4.27	Very High Knowledge
OVERALL MEAN	4.27	Very High Knowledge

Legend: 4.50 – 5.00 – Very High Knowledge, 3.50 – 4.49 – High Knowledge, 2.50 – 3.49 – Moderate Knowledge, 1.50 – 2.49 – Low Knowledge, 1.00 – 1.49 – Very Low Knowledge

Table 3. Attitudes of Respondents Toward Violence Against Women and Children (VAWC)

Indicator	*Mean*	*Interpretation*
Reporting cases	4.68	Strongly Agree
Gender norms contribute to VAWC	4.55	Strongly Agree
Survivor protection	4.74	Strongly Agree
Leadership responsibility	4.61	Strongly Agree
Training effectiveness	4.58	Strongly Agree
Inter-agency coordination	4.63	Strongly Agree
Community awareness	4.66	Strongly Agree
OVERALL MEAN	4.64	Strongly Agree

Legend: 4.50 – 5.00 – Strongly Agree, 3.50 – 4.49 – Agree, 2.50 – 3.49 – Neutral, 1.50 – 2.49 – Disagree, 1.00 – 1.49 – Strongly Disagree

Table 4. Practices of Anti-VAWC Advocates in the Implementation of Community-Based Interventions

Indicator	*Mean*	*Interpretation*
Awareness campaigns	4.41	Often
Coordination with agencies	4.32	Often
Case documentation	4.45	Often–Always
Training participation	4.28	Often
Referral protocol compliance	4.47	Often–Always
Monitoring and follow-up	3.76	Sometimes–Often
OVERALL MEAN	4.28	Often

Legend: 4.50 – 5.00 – Always, 3.50 – 4.49 – Often, 2.50 – 3.49 – Sometimes, 1.50 – 2.49 – Rarely, 1.00 – 1.49 – Never

Table 5. Perceived Effectiveness of Community-Based Anti-VAWC Interventions in Ragay, Camarines Sur

Indicator	*Mean*	*Interpretation*
Awareness campaigns	4.53	Very Effective
Referral systems	4.21	Effective
Case documentation	4.26	Effective
Inter-agency coordination	4.33	Effective
Monitoring & evaluation	3.89	Moderately Effective
Community participation	4.38	Effective
OVERALL MEAN	4.27	Effective

Legend: 4.50 – 5.00 – Very Effective, 3.50 – 4.49 – Effective, 2.50 – 3.49 – Moderately Effective, 1.50 – 2.49 – Slightly Effective, 1.00 – 1.49 – Not Effective

Table 6. Test of Relationship Between Demographic Profile, KAP, and Nature of Interventions (n = 102)

Variables	*Test Used*	*Computed Value (r)*	*p-value*	*Decision*	*Interpretation*
Demographic Profile & Knowledge	Pearson r	0.32	0.003	Reject H_0	Significant Relationship
Demographic Profile & Attitudes	Pearson r	0.28	0.007	Reject H_0	Significant Relationship
Demographic Profile & Practices	Pearson r	0.35	0.002	Reject H_0	Significant Relationship
Knowledge & Practices	Pearson r	0.61	0.000	Reject H_0	Strong Significant Relationship
Attitudes & Practices	Pearson r	0.58	0.000	Reject H_0	Strong Significant Relationship
KAP & Nature of Interventions	Pearson r	0.64	0.000	Reject H_0	Strong Significant Relationship

Legend: $p < 0.05$ = Significant

The results indicate that there is a statistically significant relationship between demographic profile, knowledge, attitudes, practices (KAP), and the nature of community-based Anti-VAWC interventions. The findings show that demographic variables such as age, sex, and educational attainment have a moderate but significant influence on the knowledge, attitudes, and practices of Anti-VAWC advocates. This suggests that individual characteristics contribute to variations in how advocates understand and implement VAWC-related programs.

More importantly, the results reveal a strong positive relationship between knowledge and practices ($r = 0.61$), as well as between attitudes and practices ($r = 0.58$). This suggests that those who support the cause, and who have more knowledge and positive views about VAWC, are more likely to use effective implementation strategies. Furthermore, the strong link ($r = 0.64$) between overall KAP and the type of interventions indicates that KAP is a key factor in determining the quality and success of community-based interventions.

The findings support the Social Ecological Model which suggest that individual factors, such as knowledge and attitudes, significantly influence behaviors and practices within a community. Furthermore, the results align with Jewkes et al.'s research, which highlights the importance of improving knowledge and changing attitudes to encourage behavioral change and reduce violence.

These findings also support the World Health Organization's view that to stop violence, you need to understand the problem and put what you've learned into practice all the time. The strong relationship observed between knowledge, attitudes, and practices (KAP) and the intervention's effectiveness suggests a direct impact of capacity-building efforts on program results. The significant correlations uncovered in this research carry several important implications. The authors first highlight the need for Anti-VAWC campaigners to participate in targeted capacity-building initiatives. These programs should be designed to improve their knowledge, attitudes, and practical skills.

Training programs should, therefore, employ a comprehensive approach that integrates legal comprehension, gender sensitivity training, and practical case management skills. Furthermore, the impact of demographic variables indicates that interventions must be contextually tailored, considering the backgrounds and attributes of the advocates involved. Customized training and support structures may be essential to mitigate disparities within particular groups.

The strong relationship between knowledge, attitudes, and practices (KAP) and how well interventions work highlights the importance of ongoing professional development and institutional support. Therefore, improving KAP is likely to enhance the effectiveness of Anti-VAWC programs, especially in areas like monitoring, referral systems, and community involvement.

Ultimately, the study's results emphasize the necessity of integrated, multi-tiered strategies for VAWC prevention. Strengthening individual capabilities must be coupled with fortifying institutional frameworks and fostering community participation to ensure enduring results.

Qualitative Findings

The qualitative results of this investigation, drawn from the unstructured feedback provided by Anti-VAWC campaigners concerning community-based programs in Ragay, Camarines Sur, are presented subsequently. These findings serve to deepen the understanding of the participants' lived experiences, the challenges they faced, and their suggested improvements, thereby complementing the quantitative data. Thematic analysis was used to identify patterns and commonalities in the responses we received.

The subsequent examples serve to clarify the research findings by illustrating the identified themes. The investigation revealed five key thematic areas: (1) challenges faced during the implementation phase, (2) factors that contribute to the reduction of violence against women and children (VAWC), (3) inadequacies within referral systems, (4) the need for improved support and training initiatives, and (5) suggestions for maximizing the effectiveness of interventions.

Table 7. Thematic Analysis of the Study

Theme	Codes (Key Ideas)	Description	Sample Verbatim Response
Challenges in Implementation	Underreporting, fear, stigma, lack of awareness, limited resources	Barriers that hinder reporting and effective intervention	"Victims are afraid to report because they depend on the abuser."
Strengthening Factors	Training, coordination, awareness campaigns, leadership support	Elements that improve effectiveness of interventions	"Continuous training helps us handle cases better."
Referral System Gaps	Delayed response, unclear procedures, weak coordination	Issues affecting efficiency of case handling	"Sometimes referrals take time because agencies are not well-coordinated."
Need for Support and Training	Counseling skills, legal knowledge, funding, tools	Capacity and resource needs of advocates	"We need more training on counseling and proper handling of victims."
Recommendations for Improvement	Monitoring systems, technology use, stronger partnerships	Suggested strategies for sustainability and improvement	"There should be a system to track cases and follow-ups."

The qualitative data clarifies the contextual factors that shape the implementation of Anti-VAWC initiatives in Ragay, Camarines Sur. A significant challenge that emerged is the underreporting of VAWC incidents, primarily stemming from victims' fear, societal stigma, and economic reliance on their abusers. This situation underscores the entrenched socio-cultural obstacles that impede the reporting of violence. These observations align with the World Health Organization's findings, which recognize underreporting as a persistent global issue in combating violence against women, especially within community environments characterized by social pressures and economic limitations. The study also highlights the importance of capacity-building and inter-agency coordination as key factors that strengthen VAWC prevention efforts. Respondents emphasized that continuous training enhances their competence and confidence in handling cases. This supports the findings of Jewkes et al., who assert that effective violence prevention requires sustained engagement, skills development, and collaboration across sectors. The presence of strong coordination mechanisms among barangay officials, law enforcement, and social services contributes significantly to the effectiveness of interventions.

Despite these benefits, the investigation reveals notable weaknesses in referral systems, particularly regarding delayed response times, unclear procedures, and inconsistent inter-agency cooperation. These identified flaws imply inherent structural inefficiencies that may hinder the timely delivery of services to those in need. The United Nations emphasizes the crucial role of a coordinated, survivor-centered referral system in ensuring that victims receive immediate and appropriate assistance.

Problems with this system could reduce trust in institutions and discourage people from reporting issues. Another important observation concerns the need for additional support and specialized training, specifically in counseling, legal procedures, and trauma-informed care. Although the participants demonstrated sufficient basic understanding, a distinct requirement for more advanced skills was evident, enabling them to effectively manage the intricate needs of survivors. Moreover, constraints in resources, including financial support, educational materials, and technological instruments, were recognized as impediments to successful execution. Therefore, improving institutional capacity requires not only training programs but also strategic investments in resources and infrastructure.

Participants provided practical recommendations for improving Anti-VAWC initiatives, particularly emphasizing the necessity of establishing monitoring and evaluation frameworks, incorporating technology-based reporting mechanisms, and strengthening collaborative partnerships among stakeholders. These suggestions highlight the importance of both long-term sustainability and systemic improvements. Monitoring is crucial, as existing research highlights the importance of tracking case outcomes. This helps ensure consistent care and the effectiveness of programs. From a theoretical perspective, the findings strongly support the Social Ecological Model, which explains that violence is influenced by multiple interacting factors at the individual, interpersonal, community, and institutional levels. For instance, underreporting reflects individual and interpersonal factors such as fear and dependency, while referral system gaps represent institutional-level challenges. This multi-level

interaction suggests that effective VAWC prevention requires comprehensive and integrated interventions.
The qualitative results carry important implications for both policy and practical application. Initially, mitigating underreporting necessitates the enhancement of community awareness initiatives and survivor-focused support structures designed to cultivate trust and diminish stigma. Furthermore, refining referral systems demands the establishment of standardized protocols and more robust inter-agency coordination strategies to guarantee prompt and effective service provision.
Furthermore, the augmentation of Anti-VAWC advocates' capabilities necessitates ongoing professional development initiatives, specifically focusing on counseling techniques, case management strategies, and trauma-informed care principles. Furthermore, Local Government Units (LGUs) are obligated to dedicate resources towards the development of strong monitoring and evaluation frameworks, integrating digital technologies to facilitate the tracking of case progression and the assessment of intervention effectiveness. The sustained success of Anti-VAWC programs, in the final analysis, hinges on fostering community engagement and collaboration across various sectors.
The qualitative data suggests that, despite the functional nature and robust advocacy surrounding community-based Anti-VAWC interventions in Ragay, substantial systemic obstacles persist. These challenges, specifically concerning reporting mechanisms, coordination among stakeholders, and the allocation of resources, constitute considerable impediments. Consequently, a comprehensive, multi-tiered strategy designed to address these issues is essential for improving the efficacy, responsiveness, and long-term viability of Anti-VAWC initiatives.

Proposed Intervention Framework

TITLE: Project SAFE: Strengthening Anti-VAWC Framework for Empowerment

Overview
The suggested intervention strategy aims to improve the effectiveness, long-term viability, and flexibility of community-based Anti-VAWC programs within Ragay, Camarines Sur. Grounded in the Social Ecological Model, this approach employs an Input–Process–Output (IPO) framework. Consequently, this structure facilitates a comprehensive, multi-tiered methodology for addressing VAWC.
Framework Components
1. Inputs
- Demographic profile of advocates
- Knowledge, Attitudes, and Practices (KAP) levels
- Existing policies (RA 9262, LGU ordinances)
- Available resources (human, financial, technological)

2. Processes (Core Interventions)
A. Capacity Building Program
- Training on VAWC laws, counseling, and trauma-informed care
- Skills development in case management and documentation

B. Strengthened Referral System
- Standardized referral protocols
- Inter-agency coordination mechanisms
- Establishment of a centralized reporting system

C. Monitoring and Evaluation System
- Development of case tracking tools (manual or digital)
- Regular monitoring and reporting of case outcomes
- Feedback mechanisms for continuous improvement

D. Community Awareness and Advocacy
- Information campaigns and community forums
- Gender sensitivity training at the barangay level
- Youth and community engagement programs

3. Outputs/Outcomes
- Improved referral system efficiency
- Enhanced gender responsiveness of services
- Increased reporting and reduced stigma
- Strengthened community participation
- Sustainable Anti-VAWC programs

Table 8. Proposed Implementation Strategy

Component	Key Activities	Expected Output
Capacity Building	Conduct quarterly training	Skilled and competent advocates
Referral System	Develop protocols and coordination meetings	Efficient and timely case handling
Monitoring System	Implement tracking tools	Improved case follow-up
Awareness Campaign	Conduct community programs	Increased awareness and reporting

Sustatinability Plan

For Project SAFE – Strengthening Anti-VAWC Framework for Empowerment – to make a real difference, several core components are absolutely necessary. Integrating the project into the structures already in place is the first step. Ongoing capacity building is also critical. Collaboration across different sectors is essential. A key step in this process involves including the program in the Local Government Unit's annual plans and financial resources. It guarantees steady financial backing for Anti-VAWC efforts, eliminating the unpredictability of short-term funding. Anti-VAWC advocates will continue to benefit from training and access to the latest resources. This ongoing support will enhance their skills in areas like case management, counseling, and providing gender-sensitive services.
Furthermore, strengthening connections among vital entities—local government, law enforcement, social services, educational institutions, and community organizations—will foster collaboration and a shared sense of responsibility.
In conclusion, although Anti-VAWC interventions in Ragay demonstrate overall efficacy, the fortification of monitoring systems, referral mechanisms, and capacity-building endeavors is crucial for enduring impact. The suggested Project SAFE framework offers a structured and practical model, designed to rectify identified deficiencies and augment the overall effectiveness of community-based Anti-VAWC programs.

Conclusion

The study's results lead to the following conclusions:
1. Anti-VAWC advocates in Ragay demonstrate robust foundational competencies, as indicated by their high levels of knowledge and positive attitudes, thereby facilitating the effective execution of community-based interventions.
2. Knowledge and attitudes exert a significant influence on practices, thereby validating the study's conceptual framework, which posits that KAP is crucial in determining the quality of Anti-VAWC interventions.
3. Community-based programs often show positive results, especially in raising awareness and encouraging community involvement. This highlights the effectiveness of grassroots approaches in addressing violence against women and children (VAWC).
4. However, systemic deficiencies persist, notably in the realms of monitoring, evaluation, and referral processes, which subsequently undermine the enduring viability and long-term effectiveness of these interventions.
5. The prevention of VAWC necessitates a multi-tiered and integrated strategy, as the Social Ecological Model suggests, wherein individual capabilities, institutional resources, and community participation jointly shape the resultant outcomes.
   Recommendations

Based on the findings and subsequent analysis, the following recommendations are put forth:
1. For Local Government Units (LGUs):
   a. Establish consistent procedures for the monitoring and evaluation of VAWC cases, complete with tracking and reporting mechanisms.
   b. Strengthen inter-agency coordination by implementing clear protocols and scheduling regular planning meetings.
   c. Ensure that Anti-VAWC initiatives and services are adequately funded and resourced.
2. For Anti-VAWC Advocates and Practitioners
   a. Engage in ongoing training, especially in areas like counseling, trauma-informed care, and case management.
   b. Improve how you document and follow up, so survivors get consistent support.

c. Run community awareness campaigns to tackle underreporting and the stigma surrounding these issues.

3. For Educational Institutions

a. Incorporate gender sensitivity and awareness of Violence Against Women and Children (VAWC) into both curricular and extension programs.
b. Collaborate with local government units (LGUs) and civil society organizations to implement community outreach and training initiatives.

4. For Policy Makers and Stakeholders

a. Formulate policies that facilitate the digitalization of referral and monitoring systems.
b. Bolster collaborative frameworks across various sectors to ensure a unified approach when addressing cases of violence against women and children.

5. For Future Researchers

a. Conduct longitudinal studies to assess the long-term impact of Anti-VAWC interventions.
b. Explore comparative studies across municipalities to identify best practices.
c. Investigate the role of technology-based interventions in improving reporting and monitoring systems.

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Problematic Social Media Use as a Persistent Concern: Reflections from Two Cohorts of Norwegian Teachers

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Abstract

The rapid expansion of social media use continues to shape communication, education, and society at large, raising persistent questions about its pedagogical, psychological, and ethical implications. Building on last year's investigation into teachers' reflections on the informational and educational dimensions of social media [1], this follow-up study examines how a new cohort of participants in the Nord University course Informational and Educational Aspects of Social-Media engages with these issues. As in the previous study, participants produced reflective blog posts as part of their coursework, and content analysis was used to identify recurring themes, concerns, and potential shifts in perspective. In line with last year's findings—where "Problematic Social Media Use" and concerns about youth mental health dominated reflections—this year's data continues to foreground the same thematic focus. Social media's influence on mental health remains a central point of concern. A comparison of the two cohorts reveals no substantive shift in professional concerns among Norwegian teachers, suggesting a stable pattern of perceived challenges across consecutive years and indicating that the profession's underlying stressors and role demands remain largely unchanged.

Taken together, these findings point to a consistent set of pedagogical needs. The stability of teachers' concerns underscores the importance of strengthening course components that address critical digital literacy and AI-augmented content ecosystems. By responding directly to the issues that persist across cohorts, the study contributes to ongoing discussions about how teacher education can more effectively prepare professionals to navigate the complexities of social media use in contemporary educational environments.

Keywords: *Problematic social media use, youth mental health, teachers' perspectives, critical digital literacy*

1. Introduction

Social media has become a defining feature of contemporary communication and education, prompting ongoing debate about its pedagogical value, psychological risks, and ethical consequences [2-4]. For teachers, these debates are not abstract: they intersect with daily professional responsibilities, expectations, and pressures. Educators must navigate students' digital behaviours, respond to concerns about wellbeing, and make informed decisions about how - or whether - to integrate social media into learning activities. As a result, teachers' reflections on social media are shaped not only by theoretical considerations but also by the practical realities of classroom management, safeguarding, and curriculum demands.

Last year's study of participants in the Nord University course *Informational and Educational Aspects of Social-Media* (IKT 1022) highlighted how concerns about problematic social media use - particularly its impact on young people's mental health - dominated teachers' reflections [1]. The present study extends this work by examining a new cohort enrolled in the same course and analysing their reflective blog posts through content analysis.

By comparing two consecutive cohorts, the study investigates whether teachers' perspectives on social media are shifting or stabilising over time. The findings indicate a striking continuity: concerns about mental health and problematic engagement remain central, suggesting that the profession's underlying stressors and perceived challenges have not substantially changed. This stability underscores the need for teacher education programmes to strengthen components related to critical digital literacy and AI-augmented content ecosystems, ensuring that training responds to the persistent issues teachers identify in their professional practice. In particular, the growing influence of AI in shaping digital content environments makes this an urgent priority. AI-driven recommendation systems, generative content, and automated amplification processes increasingly mediate what users see, how information is framed, and how social comparisons are intensified [5,6]. Without a clear understanding of how these systems

operate, both teachers and students may struggle to recognise manipulated, misleading, or emotionally triggering content.

2. Context

ICT1022 forms part of the continuing education programme *ICT and Learning 1*, which attracts practising educators from primary and secondary schools, as well as instructors and trainers working in both public and private organisations. The programme is designed to strengthen participants' digital competence and pedagogical understanding of technology-rich learning environments, with a particular emphasis on the critical, ethical, and instructional dimensions of digital media.
Within their assignment work, students are required to produce reflective blog posts in which they engage with course literature, current debates, and their own professional experiences. These blog posts serve a dual function: they operate as a pedagogical tool that encourages metacognitive reflection, and they provide a rich source of qualitative data for examining how educators conceptualise the informational and educational aspects of social media. Because participants come from diverse institutional and professional backgrounds, their reflections offer insight into how social media is perceived across different segments of the Norwegian educational landscape.
The present study draws on these blog posts to explore how teachers articulate opportunities, challenges, and concerns related to social media use.

3. Methodology

3.1 Data

This study examines blog posts produced by students enrolled in the course *Informational and Educational Aspects of Social-Media* during the autumn semester of the 2025/26 academic year. In research on digital learning environments, blog posts can function either as data in themselves or as sources that generate additional data through interactions such as comments, hyperlinks, or embedded media. In the present study, the analytical focus is limited to the content of the posts as standalone artefacts. The analysis therefore centres on the topics, sentiment, and key terms expressed in the students' reflections, rather than on extracting further information from comment threads or factual material included within the posts. Accordingly, the blog posts are treated as data, not as providers of data.
Students created their blog posts within a Confluence workspace, a platform commonly used for collaborative knowledge sharing, documentation, and project coordination. Access to the posts was shared with peers through links posted in the course's online classroom (Canvas LMS). The choice of Confluence served two pedagogical purposes: first, to support blogging as a collaborative reflective practice; and second, to familiarise students with professional digital platforms that can be used for communication and knowledge sharing in work-related contexts. A total of 23 students completed the blogging assignment (N = 23).

3.2 Analytical Framework and Procedure

The data were examined using qualitative content analysis, a method widely applied to diverse forms of human communication, including both linguistic and non-linguistic texts [7]. Written reflections such as blog posts are particularly well suited to this approach, as they provide structured yet naturally occurring material for identifying patterns of meaning.
To establish the analytical framework, the data were coded and meaning was subsequently developed through interpretive engagement [8, 9]. The analysis followed an inductive logic: no predefined coding scheme was applied. Instead, assumptions and conceptual categories emerged directly from the material, with codes constructed on the basis of meaning attributed to the students' reflections. Understanding participants' perspectives from their own standpoint was central to the process, aligning with principles associated with grounded theory [10].
The organisation and interpretation of the material unfolded in two stages. First, the blog posts were segmented into smaller units of meaning and assigned initial codes. Second, these codes were reviewed and grouped into broader categories that captured recurring themes across the dataset.
The coding process was supported by NVivo, a qualitative data analysis software (CAQDAS), which facilitated systematic organisation, retrieval, and comparison of coded segments.

4. Results

Although participants acknowledged several positive aspects of social media use - such as opportunities for social contact, access to information, and creative expression - the prevailing part of their reflections centred on its negative impact on well-being. Through iterative coding and subsequent consolidation, six overarching themes were identified.

Psychological Distress

This was the dominant theme in the dataset and was primarily driven by the code *Anxiety & depression*. It emerged from the consolidation of the codes *Anxiety & depression* and *Pressure*, which consistently clustered around participants' descriptions of emotional strain. Notably, *Anxiety & depression* was both more frequent and more widely distributed across the material than *Pressure*, appearing in 18 files and 31 references compared to 9 files and 11 references for *Pressure*. Together, these codes captured a broad spectrum of affective responses, including heightened anxiety, mood deterioration, and a persistent sense of psychological burden linked to digital environments (see Figure 1 for the NVivo coding structure underlying this theme).

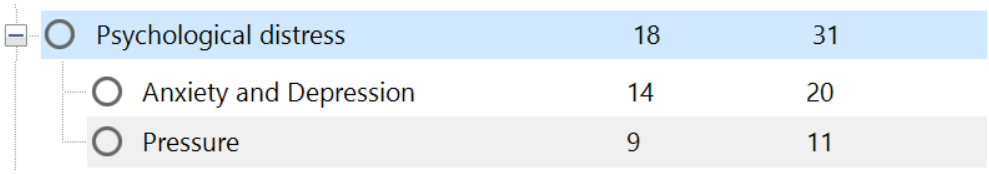


Fig. 1. NVivo coding structure for Psychological Distress

Digital Appearance Pressure

The second theme, *Digital Appearance Pressure*, was primarily driven by the code *Social comparison*. It was formed by collapsing the codes *Body image/self image*, *Digital flexing*, and *Social comparison*, which shared a common mechanism of self-evaluation shaped by online visibility. Among these, *Social comparison* was the most prominent, appearing in 11 files and 18 references. Participants highlighted how performative displays, together with continual comparisons to peers or influencers, operated as mechanisms that heightened concerns about physical appearance and personal adequacy (Figure 2 presents the NVivo structure for Digital Appearance Pressure).

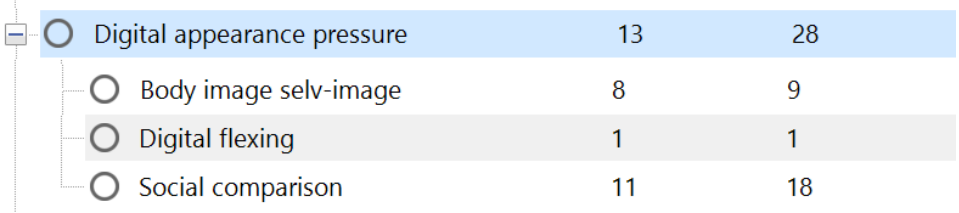


Fig. 2. NVivo coding structure for Digital Appearance Pressure

Social Harm and Isolation

The third theme, *Social Harm and Isolation*, was primarily driven by the code *Mobbing & exclusion*. It emerged from the codes *Feeling of inadequacy*, *Loneliness*, *Mobbing & exclusion*, *Strangers*, and *Exclusion if NOT*, which collectively pointed to experiences of social disconnection and exclusionary dynamics. Among these, *Mobbing & exclusion* was the most frequently referenced, appearing in 7 files and 14 references. The theme captures both interpersonal harm (e.g., bullying, exclusion, unsolicited contacts) and the broader phenomenon of social isolation amplified by online interactions (Figure 3 illustrates the NVivo coding structure supporting this theme).

Social harm and isolation	12	24
Excl. if NOT	1	1
Feelings of inadequacy	3	3
Loneliness	3	4
Mobbing & Exclusion	7	14
Strangers	2	2

Fig. 3. NVivo coding structure for Social Harm and Isolation

Curated Digital Realities

The fourth theme, *Curated Digital Realities*, was primarily driven by the code *Perfect images*. It resulted from merging the codes *Carefully selected content*, *Perfect images*, and *Perfect world*, which together described the construction of idealized, unrealistic digital environments. Among these, *Perfect images* was the most frequently referenced, appearing in 9 files and 10 references. Participants emphasized how manipulated self-presentation and highly curated content contributed to distorted perceptions of everyday life, reinforcing unattainable standards and masking the complexities of real experiences (Figure 4 shows the NVivo coding structure for this theme).

Curated digital realities	10	19
Carefully selected content	3	5
Perfect images	9	10
Perfect world	3	4

Fig. 4. NVivo coding structure for Curated Digital Realities

Problematic Digital Engagement

The fifth theme, *Problematic Digital Engagement*, was primarily driven by the code *Addiction*. It was derived from the codes *Addiction* and *FOMO* (Fear of Missing Out), which represent different but related mechanisms - compulsive use versus fear-driven engagement. Among these, *Addiction* was the most frequently referenced, appearing in 5 files and 8 references. Together, these codes describe maladaptive behavioural patterns shaped by platform design, reward loops, and constant connectivity, reflecting a behavioural domain in which digital use becomes difficult to regulate (Figure 5 displays the NVivo coding structure for Problematic Digital Engagement).

Problematic digital engagement	8	12
Addiction	5	8
FOMO	4	4

Fig. 5. NVivo coding structure for Problematic Digital Engagement

Informational Landscape Risks

The sixth theme, *Informational Landscape Risks*, was primarily driven by the code *Exposure to extreme content*. It emerged from the codes *Echo chambers*, *Exposure to extreme content*, and *Fake news*, which converge on vulnerabilities created by the contemporary information environment. Among these, *Exposure to extreme content* was the most frequently referenced, appearing in 3 files and 8 references. Participants described how algorithmic filtering, misinformation, and exposure to harmful content shape understandings of the world and contribute to feelings of confusion, polarization, or threat (Figure 6 presents the NVivo coding structure for Informational Landscape Risks).

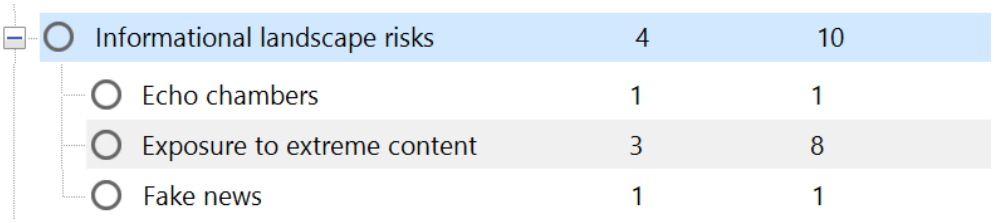


Fig. 6. NVivo coding structure for Informational Landscape Risks

5. Discussion

Taken together, the six themes identified in the analysis point toward a multilayered model of digital vulnerability that captures the complex ways in which social media environments affect young people. This model encompasses several interrelated dimensions: emotional vulnerability, identity vulnerability, social vulnerability, behavioural vulnerability, and informational vulnerability. Such a perspective aligns with broader scholarship emphasising that adolescents' online experiences are shaped not only by individual choices but also by the relational and structural dynamics of networked platforms [3,11].

Emotional vulnerability refers to experiences of psychological distress, including anxiety, insecurity, and diminished well-being - patterns that mirror evidence showing that digital environments can intensify emotional reactivity and fluctuations in mental health [12]. Identity vulnerability emerges through pressures related to appearance and the influence of highly curated and idealised representations of life, which may distort users' perceptions of themselves and others [13]. Social vulnerability involves risks associated with exclusion, negative interactions, and exposure to harmful or potentially dangerous individuals, echoing meta-analytic findings that online peer dynamics can amplify social tensions and hostile interactions [14]. Behavioural vulnerability is reflected in patterns of compulsive engagement, such as excessive use and fear of missing out (FOMO), which can reinforce dependency on digital platforms [15]. Finally, informational vulnerability highlights exposure to misinformation, algorithmically amplified content, and potentially extreme or harmful material resonating with analyses of how algorithmic curation shapes users' informational environments and can narrow or distort what young people encounter online [16].

Importantly, these layers do not operate independently. Rather, they interact dynamically, often reinforcing and intensifying one another. For instance, exposure to curated realities may heighten appearance pressure, which in turn contributes to emotional distress. Similarly, experiences of social exclusion can lead to increased and potentially problematic engagement with social media, while informational risks - such as misinformation or sensationalised content - may further exacerbate emotional strain.

Overall, these findings support a holistic understanding of digital well-being. Such an understanding moves beyond a narrow focus on individual behaviour to recognise the broader influence of social dynamics and platform design. This perspective aligns with the teachers' reflections, which implicitly acknowledge that students' online experiences are shaped not only by personal choices but also by structural and relational dimensions of digital environments.

6. Conclusion

This study examined teachers' reflections on the informational and educational dimensions of social media within the context of ICT1022, revealing how educators interpret digital platforms as complex environments that shape students' emotional, social, behavioural, and informational experiences. Across the six themes, teachers consistently framed social media not merely as a set of tools but as a socio-technical ecosystem that produces both opportunities and vulnerabilities. Their reflections highlight how psychological distress, appearance-based pressures, social exclusion, curated realities, problematic engagement, and informational risks intersect to influence students' well-being.

The findings demonstrate that teachers are acutely aware of the structural forces embedded in platform design and recognise their implications. Importantly, teachers do not view these challenges as peripheral to education. Instead, they position them as central to contemporary digital competence and as areas requiring explicit pedagogical attention.

Within the ICT1022 framework, these insights underscore the need for digital literacy education that extends beyond technical skills to include emotional resilience and critical media analysis. Teachers' reflections show that they are ready to engage with these broader dimensions, but they also signal the

need for continued professional development that equips educators to navigate and teach within increasingly complex digital environments.
Ultimately, this study contributes to a growing body of research emphasising that digital well-being, critical information literacy, and social media pedagogy must be integrated into teacher education. As digital platforms continue to shape the conditions of learning and social life, teachers' capacity to understand, interpret, and mediate these environments will remain essential.

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Translating Sustainability Strategies into Pedagogical Practice in Higher Education

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Abstract

Higher education institutions are increasingly expected to play an active role in advancing sustainable development through education, research, and institutional governance. This study examines how sustainability-oriented strategies are translated into pedagogical practice and how they are experienced by students and educators within a university setting, drawing on perspectives from education for sustainable development and student engagement theory. Using a mixed-methods approach, the research combines survey data from 175 students with semi-structured interviews conducted with educators, student representatives, and members of the university administration. In addition, institutional strategy documents were systematically analyzed to explore the relationship between strategic intentions and everyday teaching practices. The findings indicate that although sustainability is clearly articulated at the strategic level, its integration into teaching and learning remains uneven. Student awareness and engagement vary considerably, while educators describe structural constraints, limited pedagogical support, and challenges related to interdisciplinary teaching. These results suggest that sustainability education risks remaining fragmented unless it is supported by coherent pedagogical frameworks, clearer communication, and curriculum-level integration. The study contributes to education theory by offering empirical insight into how institutional strategies, pedagogical conditions, and student engagement intersect in practice, and by highlighting factors that influence the educational effectiveness of sustainability initiatives in higher education.

Keywords: *sustainability education, education for sustainable development, student engagement, pedagogical practice, higher education.*

1. Introduction

Higher education institutions are increasingly expected to play a central role in addressing global sustainability challenges through education, research, and institutional governance [1], [2]. In recent decades, sustainability has become a strategic priority for universities worldwide, reflected in institutional policies, mission statements, and international frameworks such as the United Nations Sustainable Development Goals [1], [5]. Universities are not only seen as sites for knowledge production but also as key actors in shaping future generations' competencies, values, and behaviors related to sustainable development [3], [6]. As a result, the integration of sustainability into higher education has moved beyond symbolic commitment toward expectations of meaningful educational impact [2], [4].

[1] Despite this growing emphasis at the strategic level, a persistent challenge remains in translating sustainability ambitions into pedagogical practice [4], [7]. While universities often articulate strong sustainability goals in institutional strategies and policy documents, the extent to which these commitments are reflected in teaching and learning processes is less clear [2]. Previous research has highlighted that sustainability initiatives in higher education frequently remain fragmented, with limited integration into curricula and inconsistent engagement among students and educators [7], [1], [8]. This gap between institutional intention and educational practice raises important questions about how sustainability is enacted within the everyday realities of teaching and learning [10], [7].

Education for Sustainable Development (ESD) provides a useful framework for understanding these challenges [1], [6]. ESD emphasizes the development of competencies that enable learners to critically engage with complex sustainability issues and to contribute to societal transformation [6]. However, achieving these outcomes requires more than the inclusion of sustainability content; it demands pedagogical approaches that actively engage students and foster interdisciplinary learning, critical thinking, and real-world application [6], [10]. At the same time, student engagement theory suggests that meaningful learning is closely linked to students' active participation, perceived relevance of content, and interaction with educators and peers [9]. From this perspective, the effectiveness of sustainability

education depends not only on institutional strategies but also on how these strategies are experienced and enacted within the learning environment [6], [9].
Existing literature has explored sustainability in higher education from various perspectives, including policy development, curriculum design, and institutional transformation [2], [4]. However, less attention has been given to the process through which sustainability strategies are translated into pedagogical practice and how this process is shaped by the interaction between institutional structures, educators, and students [4], [10]. In particular, there is a need for empirical research that examines both the strategic intentions of universities and the lived experiences of those involved in teaching and learning [10]. Understanding this translation process is essential for identifying why sustainability initiatives often fail to achieve their intended educational impact [7], [10].
This study addresses this gap by examining how sustainability-oriented strategies are translated into pedagogical practice within a higher education context. Focusing on the University of Stavanger as a case study, the research adopts a mixed-methods approach combining survey data from students, semi-structured interviews with educators, student representatives, and administrative staff, and an analysis of institutional strategic documents. By integrating multiple sources of data, the study provides a comprehensive view of how sustainability is positioned at the strategic level and how it is experienced in practice.
The aim of this paper is therefore to explore the relationship between institutional sustainability strategies and pedagogical practice, with particular attention to student engagement and educator perspectives. More specifically, the study seeks to understand (1) how sustainability is articulated in institutional strategies, (2) how these strategies are reflected in teaching and learning practices, and (3) how students and educators experience and interpret these processes. By doing so, the paper contributes to research on education for sustainable development by offering empirical insight into the conditions that shape the effectiveness of sustainability education in higher education. To better understand how sustainability strategies are translated into pedagogical practice, the following section presents the theoretical perspectives that guide the analysis, with particular attention to Education for Sustainable Development and student engagement.

2. Theoretical Framework

The integration of sustainability into higher education is commonly framed within Education for Sustainable Development (ESD), which emphasizes the role of universities in preparing students to address complex global challenges [1], [6]. ESD focuses on the development of competencies such as critical thinking, systems thinking, and the ability to engage with real-world problems, requiring pedagogical approaches that are participatory, interdisciplinary, and practice-oriented [6].
Despite this emphasis, sustainability integration in higher education often remains uneven [7]. While many institutions have adopted sustainability as a strategic priority, its implementation in teaching and learning is strongly influenced by individual educators and disciplinary contexts. This highlights a gap between institutional sustainability commitments and educational practice, suggesting that strategic commitment alone is insufficient to ensure meaningful sustainability education [7], [10]. Student engagement theory provides a complementary lens for understanding this gap. Engagement is closely linked to active participation, cognitive involvement, and perceived value and relevance of learning [9]. In sustainability education, this is particularly important, as students must connect theoretical knowledge with practical and societal applications [6]. Active and experiential learning approaches are therefore associated with higher levels of engagement and deeper understanding [12], [9].
These perspectives highlight the importance of pedagogical design in shaping how sustainability is experienced by students. Educators play a central role as mediators between institutional strategies and classroom practice, but their ability to integrate sustainability is influenced by institutional conditions such as pedagogical support and opportunities for interdisciplinary collaboration [10], [7]. In the absence of coordinated support, sustainability integration often remains fragmented [7], [4].
The relationship between institutional strategies and pedagogical practice can therefore be understood as a process of translation rather than direct implementation. Institutional policies articulate sustainability intentions, but these must be interpreted and enacted within teaching contexts [10]. This process is shaped by the interaction between institutional conditions, pedagogical practices, and student engagement, resulting in varying degrees of alignment between sustainability goals and learning outcomes [10], [6], [9].
Building on these perspectives, this study examines how sustainability strategies are translated into pedagogical practice in higher education, with a focus on the conditions that influence this process and its implications for student engagement and learning.

3. Methodology

This study adopts a mixed-methods approach to examine how sustainability-oriented institutional strategies are translated into pedagogical practice within a higher education context. The study combines three sources of data: a student survey, semi-structured interviews, and institutional document analysis (see Figure 1). Data were collected during Spring 2024 at the University of Stavanger. The mixed-methods design was selected to provide both breadth in understanding student perspectives and depth in exploring institutional and pedagogical experiences. Semi-structured interview guides and a survey instrument were developed in alignment with the study's research questions and theoretical framework, with interview prompts adapted to different participant groups. [2]

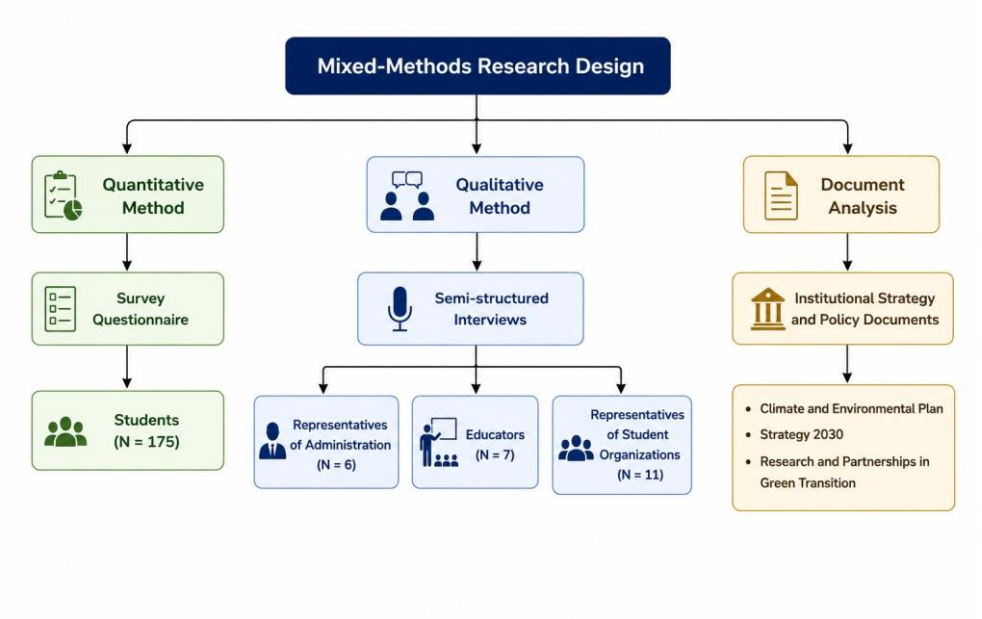


Fig. 1. Overview of the mixed-methods research design

An overview of the study's data sources, participants, and analytical approaches is presented in Table 1.

Table 1. Overview of data sources and analytical approaches

Data source	Participants / Material	Purpose	Analysis method
Student survey	175 UiS students	Explore sustainability awareness, educational exposure, and engagement	Descriptive and exploratory statistical analysis
Semi-structured interviews	24 informants	Explore pedagogical and institutional experiences	Thematic analysis
Institutional documents	Strategy and policy documents	Examine sustainability discourse and institutional priorities	Qualitative document analysis

A total of 182 responses were initially collected, of which 175 valid responses from University of Stavanger students were retained for analysis. Quantitative data were collected through a survey distributed to students across different study programs at the University of Stavanger. The demographic characteristics of the survey participants are presented in Table 2.

Table 2. Demographic characteristics of survey participants (N = 175)

Variable	Category	n (%)
Gender	Women	111 (63.4)
	Men	64 (36.6)
Age	19–21	59 (33.7)
	22–25	82 (46.9)
	26–29	22 (12.6)
	30+	12 (6.9)
Study level	Bachelor programs	95 (54.3)
	Master programs	76 (43.4)
	Other	4 (2.3)
Largest field representation	Economics and Law	62 (35.4)
	Health Sciences	39 (22.3)
	Teacher Education	23 (13.1)

The structure of the survey instrument is presented in Table 3.

Table 3. Structure of the survey instrument and question categories

SECTION	EXPLANATION
A	Demographic information and control questions were measured using five single-choice format questions.
B	General knowledge about sustainability, survey questions included one closed yes/no question, three single-choice questions, and one question using a five-point Likert scale (1 = “I completely disagree” to 5 = “I completely agree”).
C	The five competencies were measured as follows: • Systems Thinking was measured with four items using one closed question each. • Anticipatory Competence was measured with four items using a five-point Likert scale ranging from 1 = “I completely disagree” to 5 = “I completely agree”. • Normative Competence was measured with four items using a five-point Likert scale ranging from 1 = “I completely disagree” to 5 = “I completely agree”. • Strategic Competence was measured with four items using a five-point Likert scale ranging from 1 = “I completely disagree” to 5 = “I completely agree”. • Interpersonal Competence was measured with four items using a five-point Likert scale ranging from 1 = “I completely disagree” to 5 = “I completely agree”.
D	Customized questions were measured with six items using a five-point Likert scale (1 = “I completely disagree” to 5 = “I completely agree”).

The survey explored students’ awareness of sustainability, their exposure to sustainability-related education, perceptions of institutional sustainability efforts, and engagement with sustainability initiatives. The survey data were analyzed using descriptive and exploratory statistical methods to identify patterns and variations in students’ sustainability awareness and engagement across educational contexts.

Qualitative data were obtained through semi-structured interviews with 24 informants: six representatives from administration/top management, seven educators, and eleven student organization representatives. The interviews were conducted between 23 April and 8 May 2024, either face-to-face on campus or digitally via Microsoft Teams, depending on participant availability. Different semi-structured interview guides were developed for each participant group in alignment with the study’s research questions and theoretical framework.

The interviews focused on participants’ experiences with sustainability in teaching, institutional priorities, and perceived challenges in integrating sustainability into pedagogical practice. The interview data were transcribed and analyzed using thematic analysis to identify recurring patterns and key themes.

In addition, institutional strategy documents were examined through qualitative document analysis to

explore how sustainability is articulated at the policy level and how these strategic intentions relate to educational practices. The combination of survey data, interview insights, and document analysis enables a comprehensive understanding of the relationship between institutional strategies and pedagogical implementation.

4. Results

The findings are structured around three key dimensions: (1) the relationship between institutional sustainability strategies and pedagogical practice, (2) student awareness and engagement, and (3) educators' experiences and perceived constraints.

4.1 Strategic Commitment and Pedagogical Practice

The analysis of institutional documents shows that sustainability is clearly positioned as a strategic priority. The university emphasizes its role in contributing to sustainable development through education, research, and societal engagement, with explicit alignment to the United Nations Sustainable Development Goals. The document analysis was based on three institutional sources: the Climate and Environmental Plan, Strategy 2030, and UiS material on research and partnerships in green transition, all of which repeatedly connected sustainability to educational development, research activity, institutional operations, and societal transformation.

However, this strategic commitment is not consistently reflected in pedagogical practice. While sustainability is present in some courses and programs, its integration appears uneven and largely dependent on individual initiatives. Interview findings suggested that sustainability integration often depended on individual educator initiative rather than systematic curriculum design. As one educator explained, "Yes, It's quite free, in that sense, to organize the teaching. In that sense, the organization doesn't interfere much with the content of the teaching".

These findings indicate inconsistencies between institutional sustainability strategies and their implementation in teaching practices. Although sustainability is well articulated at the policy level, its translation into pedagogical practice lacks coherence, resulting in fragmented implementation across disciplines.

4.2 Student Awareness and Engagement

Survey findings indicate variation in students' awareness and engagement with sustainability. This variation was particularly visible in students' reported exposure to sustainability-related content across different study programs. While many students recognize the importance of sustainability, a substantial proportion report limited exposure to sustainability within their formal education. Perceptions of the visibility and consistency of the university's sustainability efforts also varied among respondents.

Students reported differing experiences regarding how sustainability was integrated into teaching and learning. While some participants experienced sustainability as visible within courses and educational activities, others perceived sustainability integration as limited or inconsistently addressed across programs. As one student representative stated, "I would have appreciated more sustainability in all study programs".

Perceptions of the visibility and consistency of the university's sustainability efforts also varied among respondents. Some participants considered current sustainability efforts sufficient, while others perceived sustainability integration as limited across educational contexts. As one participant noted, "I think the university could have even more focus on integrating sustainability into teaching and research". This variation indicates that student engagement is shaped not only by institutional strategies but also by how sustainability is integrated into learning experiences.

4.3 Educator Perspectives and Constraints

Interviews with educators and administrative staff reveal several challenges in integrating sustainability into teaching. While sustainability is widely recognized as important, its implementation is constrained by structural and pedagogical factors.

A key issue identified is the lack of structured pedagogical support. Although sustainability is emphasized at the strategic level, many educators described limited pedagogical guidance and insufficient institutional support for integrating sustainability into course design. As one educator explained, "Yes, it's quite free, in that sense, to organize the teaching. In that sense, the organization

doesn't interfere much with the content of the teaching". The analysis further revealed that "educators usually have great freedom to determine the curriculum content themselves", resulting in sustainability integration often depending on individual initiative rather than coordinated institutional practice.
Interdisciplinary collaboration was also highlighted as both necessary and difficult. One educator described this challenge by stating, "We do try, but it's difficult in an organization like this to make it happen… There are quickly tensions because there are silos here that are working towards their own interests, which means they don't want to let go of any of their resources. So, there is a desire for it, but I think it's quite difficult to achieve".
The thesis additionally notes that "the lack of clear guidelines and sufficient resources, combined with the expectation gap between students and educators, contributes to difficulties in encouraging student involvement in sustainability beyond the classroom". Interdisciplinary collaboration was also highlighted as both necessary and difficult. Educators acknowledged the importance of cross-disciplinary approaches but noted that institutional structures and disciplinary boundaries often limit collaboration.
In addition, tensions between academic autonomy and institutional direction contribute to variability in implementation. While educators have considerable flexibility in course design, the absence of coordinated institutional support contributes to uneven integration of sustainability across teaching practices and programs.

4.4 Summary of Findings

Overall, the findings reveal inconsistencies between institutional sustainability strategies and their implementation in teaching and learning practices. While sustainability is strongly represented within institutional policies and strategic priorities, students and educators described uneven integration across courses and programs. Variations in student engagement, limited pedagogical support, and challenges related to interdisciplinary collaboration emerged as key factors influencing how sustainability was experienced within the educational environment.

5. Discussion

From an education for sustainable development (ESD) perspective, the results suggest that the presence of sustainability at the strategic level does not automatically lead to effective pedagogical integration [11], [7]. While the university demonstrates a clear commitment to sustainability in its policies and strategic documents, this commitment is not consistently reflected in teaching and learning practices. This supports existing research indicating that sustainability initiatives in higher education often remain fragmented when not supported by structured pedagogical frameworks [7], [10]. The findings therefore reinforce the view that sustainability education requires more than institutional endorsement; it depends on the conditions under which teaching is designed and delivered [6], [11].
A key contribution of this study lies in highlighting the role of pedagogy as a mediating factor between institutional strategy and educational outcomes. The variation observed in student engagement suggests that learning experiences are shaped by how sustainability is integrated into the curriculum rather than by the existence of institutional strategies alone. In particular, the results indicate that students are more engaged when sustainability is approached through applied and practice-oriented methods, such as project-based learning and real-world problem solving. This aligns with student engagement theory, which emphasizes the importance of active participation and perceived relevance in promoting meaningful learning [12], [9].
At the same time, the findings draw attention to the structural and institutional constraints that shape pedagogical practice. Educators' experiences reveal that, despite recognizing the importance of sustainability, they often lack the necessary support to integrate it effectively into their teaching. The absence of clear guidelines, limited access to pedagogical resources, and challenges related to interdisciplinary collaboration contribute to inconsistencies in implementation. These findings suggest that the translation of sustainability strategies into practice is not solely an individual responsibility but is influenced by broader institutional conditions [10], [13].
[3] The tension between academic autonomy and institutional coordination in sustainability implementation further complicates this process. While flexibility in course design allows educators to adapt content to their disciplines, it also results in variability in how sustainability is addressed. Without coordinated efforts to support integration at the curriculum level, sustainability remains dependent on individual initiative rather than being embedded systematically across programs. This reinforces the need for institutional mechanisms that facilitate collaboration, provide pedagogical support, and ensure coherence in sustainability education [10], [13].

Taken together, the findings indicate that sustainability education in higher education is shaped by the interaction between institutional strategies, pedagogical practices, and student engagement. This interaction highlights the importance of viewing sustainability not only as a strategic priority but as an educational process that requires alignment across multiple levels of the institution. The results therefore contribute to education theory by demonstrating how institutional intentions are mediated by pedagogical and structural factors, influencing the extent to which sustainability becomes meaningful in students' learning experiences [14], [12].

6. Conclusion

This study examined how sustainability-oriented institutional strategies are translated into pedagogical practice within a higher education context. The findings indicate inconsistencies between institutional sustainability ambitions and their implementation in teaching and learning practices. Although sustainability is clearly emphasized within institutional strategies and policy documents, its integration into pedagogical practice remains uneven across courses and programs. Variations in student engagement, limited pedagogical support, and structural constraints experienced by educators were identified as important factors influencing this process.

The findings further suggest that institutional commitment alone is insufficient to ensure meaningful sustainability education [7]. Instead, the educational impact of sustainability initiatives depends on how sustainability is integrated into teaching and learning environments. Students reported different experiences regarding sustainability integration, while educators highlighted challenges related to limited guidance, insufficient resources, and difficulties associated with interdisciplinary collaboration. The study also indicates that students experience sustainability as more meaningful when it is visible and connected to their educational experiences.

From a theoretical perspective, the study contributes to research on education for sustainable development by illustrating how institutional strategies, pedagogical practices, and student experiences interact in shaping sustainability education within higher education. The findings support previous research suggesting that sustainability implementation is influenced not only by strategic priorities, but also by the institutional and pedagogical conditions through which these priorities are translated into practice [12].

The findings additionally have implications for policy and practice in higher education institutions. Strengthening sustainability education requires clearer pedagogical support, stronger curriculum-level integration, and improved opportunities for interdisciplinary collaboration. Greater coordination and communication across institutional levels may further contribute to more coherent sustainability implementation and more consistent student experiences.

Future research could further explore how sustainability integration differs across disciplinary contexts and educational levels, as well as how different pedagogical approaches influence students' sustainability engagement and competencies over time.

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Sustainability and Community Tourism in the Amazon Region. The Experience of “Santa Helena Del Ingles”. Collective and Individual Dynamics and the Role of Education

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Abstract

While the Amazon biome can be divided into several Amazons, either by social, economic, cultural and environmental characteristics, in the area near Manaus, sustainable and community-based tourism is becoming an important resource for the "ribeirinha communities" (communities, whose members are of mixed origin- called "caboclos"). The main activity of these communities was woodcutter, until this region became a Sustainable Development Reserve (RDS) in 2008. Since the creation of this reserve, the communities had to find other activities. The paper follows the experience of the community of Santa Helena del Ingles (Saint Helen of the English) that, with the support of the Foundation for Amazon Sustainability, progressively developed other means of economic activity, such as sustainable tourism (they built a community hostel), handicrafts, production of natural products to sell the tourists. The opening of the community hostel has created at the same time collaborative dynamics and individual entrepreneurship, when some members have themselves opened new structures for hosting tourists. This new shift, which has seen women as the main actors, has been accompanied by specific university training that has represented an important achievement for people who had never considered this possibility. The paper describes the context and analyses the conditions for the community empowerement. Among the conditions, we underline the participation to a pioneering initiative, implemented by the Nilton Lins University, a graduation in Tourism Management, which began in 2022 in partnership with the Amazon Sustainable Foundation, and offers the course remotely, through distance education, making professional training more accessible to students far from large urban centers. It also includes scholarships. The Nilton Lins course focuses on empowering traditional communities for the development of community-based tourism and fostering local entrepreneurship. Students are guided to explore business opportunities, especially in the areas of accommodation, tours, restaurants, and other services already offered informally.

Keywords: *Sustainability, Empowerment, Tourism, Community*

Introduction

In November 2025, I did a fieldwork on women's participation in the management of sustainable tourism, as part of a project on sustainability in the Amazon region, in the Rio Negro Comunidade Santa Helena do Inglês, located in the municipality of Iranduba, about 40 km. from Manaus. This article starts from that experience, the article develops some theoretical reflexions about traditional communities, sustainability and ecological issues, processes of modernization/globalization and profit/capitalist logics.



Fig. 1. Community House at Santa Helena, where meetings are held

Santa Helena do Inglês is located within the Rio Negro Sustainable Development Reserve (RDS), established in 2008 for the protection of the Amazon rainforest. The creation of the Rio Negro Sustainable Development Reserve (RDS) brought about major transformations for the 19 communities within the area, whose populations, in addition to fishing and mini-agriculture, lived by selling forest firewood. Following the new territorial statute, and, for ecological reasons, the obligation of stopping with wood extraction, nine communities developed activities related to tourism and crafts.



Fig. 2. View of the Rio Negro from the Pousada (Guesthouse)

My fieldwork focused on women's participation in the management of sustainable tourism, as part of a project on sustainability in the Amazon region. In fact, women seemed particularly favorable to the reconversion imposed for ecological reasons. Most people in the *riberinha* communities were loggers spending their life deep in the Amazon rainforest. "*Before, we lived off logging; it was our only income. But in 2008 logging was prohibited, so it became very difficult for all the communities. Many people left for the capital in search of work. That's when the idea of community-based tourism emerged*," says Adriana, who has been the first manager of the community guesthouse Vista Rio Negro and now has opened her own place. Women became very active in the new activity, which gave them a prestigious role and allowed the contact with very different people.
Moreover, during the field work, I got to know the specificities of the *ribeirinha* community life, based on a strong idea of collective work and solidarity principles. According to the traditional community life, the decisions are always taken collectively in popular assemblies. This pattern fully worked in the passage from logging to the activity of community tourism.
The project of sustainable/community tourism was introduced and developed with the help the Fundação Amazônia Sustentável (FAS) that suggested as well other alternative activities. The community members opted for tourism because, in the meantime, other communities in the reserve had been working with tourism. The opening of a pousada (red and breakfast) Vista Rio Negro has been a collective work and profits have to be beneficial for the whole community.
The collective choice of tourism is so far seen in a very positive way by the community- as a form of exchange with the foreign people who come to visit and as the best way to preserve their lifestyles and the nature of the forest, accepting the abandon of wood extraction. The experience shows an interesting articulation between the preservation of the traditional way of life, the ecological sustainability and market principles. The article concludes on the conditions that can allow this positive articulation to continue.

The Riverside Communities/*Comunidades riberinhas* in the Amazon Region

The Brazilian Amazon is composed of a variety of indigenous peoples and ethnicities, and a population resulting from miscegenation, called "*caboclo*", a consequence of the colonization and occupation process that occurred in the region (Arenz, 2000). Miscegenation was then shaped through the settlements of missionaries and in the villages of colonists, from the 17th to the 19th centuries.
From 1850 onwards, the *caboclo* population increased due to an intense migration process, mainly from people from the Northeast of Brazil, at a time when the extraction of latex in the rubber plantations (raw material for rubber production) represented a moment of great wealth for the region.
These new residents settled along the riverbanks, giving rise to the term "ribeirinhos" (river dwellers). "*At every mouth of streams and rivers with resources and possibilities for exploitation, there was a post or trading post whose function was to channel the agro-extractive production brought from the interior lands and to drain it to the ports and larger cities*." (CASTRO, 2008, p. 17-18). Even when, after 1910-20, rubber exports declined due to English competition in the Asian colonies, resulting from the smuggling of the seed of the Brazilian rubber tree, the *caboclo* migrants didn't go back and stayed in the Amazon region.
The term "riverside dweller", then, seeks to identify a sociocultural profile of *caboclo* groups that settled on the banks of rivers, in a dynamic space that articulates the relations of sociability and culture within the particularities of that space, where the mark of this configuration can be seen in behaviors, in the way of life, in their food, in their beliefs, in their religiosity, etc., specific to that space. Nowadays the term "*ribeirinha*" community refers mainly to *caboclo* population. In fact, starting in the 1990s, when residents began to identify themselves as indigenous, they replaced the term community with "aldeia" village.



Fig. 3. Adriana is explaining the medical plants

Even marginalized, the “Ribeirinha” communities managed to resist total assimilation, preserving the main axes of their ancestors' culture: economic aspects (integration with nature, plant extraction), social aspects (autonomous living in small communities and work collectively, as many activities, such as fishing, agriculture, and housing construction, are carried out in communal work), and religious aspects (syncretism between Catholicism and practice of shamanism). According to Arenz, they consider that "*the Portuguese language and the Catholic religion are 'bridges' to the world of the 5'whites,' but they did not determine or fully express the social and cultural autonomy of the riverine communities*" (ARENZ, 2000, p. 12). They also have specific legends and specific mythological beings, as the curupira and the mapinguari or ishnashi, forest’s monstera and, at the same time, forest’s guardians.

Women's participation plays a prominent role in the communities. They actively contribute to family income and are involved in numerous activities. They have also the knowledge of the herbal treatments and they have the role of “curandeiras” (See picture, woman from Santa Helena, explaining the plants that are cultivated and that are used for different treatments).

The role of women was promoted in this new phase when the activities shifted from wood extraction to sustainable and community tourism. Abandoning their main economic activity—logging—wasn't easy and migration eventually occurred. That’s why the idea of community-based tourism, proposed by the Fundação Amazônia Sustentável (FAS) appeared as way of saving various communities on the river. That’s what happened in Santa Helena. Adriana, who first managed the guesthouse Vista do Rio, among many difficulties, as it didn’t always generate enough income, and then has opened her own space, insists on the positive aspects, repeating what she has learned in a training course online she followed at the University Nilton Lins in Manaus: “*Community-based tourism is a way of experiencing a destination from the perspective of those who live there. In practice, this means experiences led by the communities themselves, valuing local culture, generating income, and respecting the Amazon rainforest and way of life.*”

The community of Santa Helena de l'Ingles and the Building of the Posada Vista Rio Negro

The community that nowadays is composed by around 400 people, was founded in 1969 by Demétrio Vidal de Mendonça, father of ten children: "*When I arrived here it was all forest. I arrived single, worked for a year and then got married. I built a family, built a house and started planting crops, but my main activity was logging. I have many stories to tell*," he recalls. Other families (parents and friends), followed from the Northern part of the Rio Negro, in order to be closer to the city of Manaus, and the community got larger. An Englishman with his wife settled there for a few years, sharing the life of the community. For this reason, Santa Helena became Santa Helena de l'Ingles.
A logger, Demetrio had to stop the activity when the area became protected, as part of the Rio Negro Sustainable Development Reserve, and the community had to live only from planting crops and fishing. The production of the mandioca flour was good, but it was difficult to find a market. With the development of tourism, it became also easier to sell agricultural products. In fact, with tourism being developed, the economy was also boosted by selling what they plant. "*The main difference between the time of deforestation and now is that today we already have someone to sell flour to, we can sell fish, there is a market here, especially for tapioca starch and cassava. Back then, only wood brought in money. We live like this, there is no longer a need to cut the wood that we used to cut, it was very hard work*."
The shift to tourism took place in 2014, with the opening of the guesthouse, with the support of the Sustainable Amazon Foundation (FAS), created in 2008, a non-profit civil society organization that promotes sustainable development in the Amazon. Recognized as a social assistance entity, FAS works to guarantee the rights of traditional populations in riverside communities, indigenous peoples, quilombola communities, and peripheral areas through a systemic approach, contextualized action, social empowerment, development, and innovation.
FAS's work in tourism focuses on Community-Based Tourism (CBT), a modality that promotes authentic experiences, values local knowledge, and generates direct income for families, helping to protect the forest. The goal is to empower forest entrepreneurs. The aim is that people understand, when they start having an awareness focused on tourism, that the forest is much more valuable standing than actually cut down. As for the tourists, they are enchanted by the hospitality, simplicity, and wisdom of the riverside caboclos. This exchange is really appreciated as well by the community dwellers.
The community guesthouse was built in 2014 as a collective work. The community has a president, but all the decisions are taken collectively in democratic debates. The FAS found the grant for the guesthouse and the community built the place, the workers were paid three days and gave two days of work free. The manager and the personnel were chosen in open meetings
The income from the guesthouse was shared collectively. A part of the income remained for ensuring the future functioning of the guesthouse.



Fig. 4. The Pousada Da Dri

Adriana was the first manager, for five years. Now a new person -always woman- was chosen. And finally, Adriana has decided to open her own guesthouse, the Pousada Da dri, after a long collective discussion in the village meetings, and, even if the guesthouse is private, the all community has to benefit.

The Nilton Lins University and the Role of Education

The passage of Adriana from employee by the community to self-employed was facilitated by the opportunity to take courses on Tourism at the Nilton Lins University, located in Manaus. The Nilton Lins University's mission is "Educating the Amazon," and this mission is reflected in an education focused on sustainability with strong Amazonian roots, established for about four decades in the heart of the Amazon. Internationally recognized the University frequently receives exchanges and visits from international tourism students especially interested the local ecotourism.
The University offers programs focused on the tourism sector, including a three years degree in Tourism with a strategic focus on the vocations of the Amazon region. The course qualifies professionals to work as managers, guides, and travel agents, with a strong emphasis on ecotourism, sustainability. and hotel management. A part of the program is consacrated to Sustainable Tourism. A tourism professional can work in hotels and restaurants; in airlines and cruise lines; in event organization; in the management of inns, travel agencies and tour operators, transportation, events and leisure, consulting and advisory firms in the area of creation and analysis of tourism projects. They can also specialize in marketing actions aimed at the sector and the management of public policies for the segment.
More, in 2021, recently, always in partnership with the FAS an innovative Tourism Management Technology course, the "University Students of the Forest" program in partnership with FAS, the only one in the country with an Amazonian identity and training for sustainability has been introduced, focusing on training Amazon residents through distance learning. The "University Students of the Forest" program won 2nd place in the National Tourism Award from the Ministry of Tourism in 2025.
Finally, in 2022, in partnership with FAS, the Nilton Lins has opened a new course, offered in the distance learning modality, making professional training more accessible to students far from large urban centers: it is aimed to empowering traditional communities for the development of community-based tourism and fostering local entrepreneurship. Combining higher education with practical experiences, the course guides the students to explore business opportunities, especially in the areas of accommodation, tours, restaurants, and other services that are already offered informally. The program also includes also includes scholarships. Adriana was one of the first beneficiaries of the program, which, she says, changes her professional perspectives and also her vision or herself and her community: “I would have never dreamt, in my best dreams, to go to University and an academic training.” She says.
This initiative is practically transforming the educational and socioeconomic landscape of traditional communities in Amazonas with the graduation, at the end of 2024, of the first class of 20 residents from the Rio Negro and Uatumã Sustainable Development Reserves in Tourism Management. João Emanuel, professor and coordinator of the Tourism course at Nilton Lins, highlights the power of education as a tool to empower and create opportunities for the Amazonian population and the importance of qualification for the communities involved.
"In addition to the skills to manage tourism ventures and provide a solid economic base in the medium term, resulting in the creation of new jobs, the training promotes the appreciation of the rich cultural traditions of the communities."
The professor also emphasizes that the course addresses the need for environmental preservation. "Activities that are major attractions for visitors, such as artisanal fishing, forest walks, and river and beach tours, are only possible with respect for fauna, flora, and sustainability," he points out.
The course curriculum covers fundamental subjects, including hotel design, team management, entrepreneurship, art, culture and heritage, as well as event management. With the graduation of the first class approaching, the coordinator reveals that the goal is to expand the initiative to other traditional communities in the interior of the state.

Conclusions

The way of life of the riverside communities, whose daily lives are directly influenced by the river flows and by the forest, has undergone social, political, economic, cultural, and territorial transformations.
Considering the perspective of the territory used, it is appropriate to reflect on the use of the Amazonian territory in the context of the globalized world. For Santos (2001), globalization is, in a way, the apogee of the internationalization process of the capitalist world. The new world order, which he calls perverse

globalization, is sustained by a dominant ideology that overvalues the market and encourages consumption, competitiveness, and individuality, to the detriment of solidarity and morality. "*An overwhelming market, said to be global, is presented as capable of homogenizing the planet when, in fact, local differences are deepened*" (SANTOS, 2001, p. 19).

Regarding the Amazon region, Hurtienne (2009) states that the Amazon has always been considered by global society as one of the last frontiers for the exploitation of resources in the expansion of the world economy, an economic space for the accumulation of national and international capital. However, from an ecological point of view, it is considered one of the last biological reserves, an immense deposit, a climate stabilizer, a patrimony of global society that needs to be cared for.

These two dimensions that make up this discourse, the economic and the ecological, are opposite and contradictory, since the dominant model of globalization is based on the exploitation of non-renewable and difficult-to-recycle resources.

However, some local experiences seem to be able to combine ecology and improvement of local populations. The case of sustainable tourism in Santa Helen of the Ingles seems one. The experience shows an interesting articulation between the preservation of the traditional way of life, which is also put in value by the education process through the work of the University Nilson Lins, the ecological sustainability and income generation activities. This positive articulation is possible as far as the collectivity and solidarity principle inside the community is preserved: this seems to be the case so far and is even reinforced by the growing role of the women; however, the continuous support of the FAS and, more recently, the role of the University in training the local people are also a condition for this positive articulation. The University shows the power of education as a tool to empower and create opportunities for the Amazonian population and the importance of qualification for the communities involved. The FAS organizes as well training course to develop other activities of crafts and natural cosmetics. Together with the FAS, national and local governments have also given support with the introduction of solar panels that represent an important resource both for everyday life and tourism. Finally, the type of tourism -community tourism- that is promoted is practiced by a very specific type of public that is interested in exchange with people and connection with nature more than leisure and luxury. All these aspects contribute to preserve the experience by a logic of profit and exploitation.



Fig. 5. Solar Panels

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Natural Parks as Local Agents of Sustainability: Institutional Perceptions of the Role of Gaia Biological Park in Promoting Sustainable Development

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Abstract

In the context of the 2030 Agenda, natural parks are increasingly recognized as spaces that mediate between science, society, and nature, contributing to the promotion of Sustainable Development (SD). This study focused on analysing institutional perceptions regarding the contribution of the Gaia Biological Park (PBG) to the promotion of SD, specifically examining interview results obtained from directors of the Department of Environment and Urban Parks of the Municipality of Vila Nova de Gaia. The research followed a qualitative case study approach, using semi-structured interviews conducted with directors directly involved in the management of the PBG. The sample comprised three directors (n=3), corresponding to 60.0% of the department's leadership. Results reveal institutional consensus concerning the role of the PBG as a space promoting sustainable development, with all interviewees (n=3; 100.0%) stating that the park's activities predominantly align with this domain. All participants (n=3; 100.0%) also demonstrated familiarity with the Sustainable Development Goals (SDGs) and identified SDGs 4 (Quality Education), 11 (Sustainable Cities and Communities), 12 (Responsible Consumption and Production), and 15 (Life on Land) as the most represented within park activities, indicated by two interviewees (n=2; 66.6%), while one director (n=1; 33.3%) explicitly added SDG 13 (Climate Action). In terms of institutional governance, all interviewees (n=3; 100.0%) stressed the importance of strengthening collaboration between municipal departments and developing partnerships with universities, companies, and the local community, also recognizing the need for strategic instruments ensuring continuity of activities. An optimistic perception regarding the continuity of park initiatives despite political changes also prevails among all participants (n=3; 100.0%). The findings indicate that the PBG is institutionally recognized as a relevant agent for local sustainability promotion, contributing to environmental literacy, visitor diversification, and reinforcement of territorial identity associated with conservation and environmental education. These results reinforce the role of natural parks as strategic instruments of local governance for sustainability and highlight the importance of Science Communication in consolidating environmental citizenship practices.

Keywords: *Science Communication; Case study; Natural Parks; Sustainable Development; Environmental Literacy; Institutional Perceptions.*

1. Introduction

The implementation of the 2030 Agenda and the Sustainable Development Goals (SDGs) has reinforced the urgency of promoting pro-environmental behaviours capable of reducing environmental impacts and supporting more sustainable development pathways. The 2030 Agenda establishes a broad and ambitious framework that integrates multiple dimensions of Sustainable Development (SD), while encouraging social responsibility, justice, and effective citizenship practices. Achieving these goals depends not only on political and institutional action but also on the active participation of citizens and changes in individual behaviour patterns [1].
Voluntary Local Reviews (VLRs), supported by the *European Handbook for SDGs Voluntary Local Reviews* [2], have improved local monitoring capacities and strengthened cities' abilities to assess their progress towards the SDGs while supporting governance and long-term planning processes. Nevertheless, the transition towards sustainability largely depends on public engagement and behavioural transformation. Current anthropogenic systems continue to encourage unsustainable

lifestyles characterised by excessive consumption and environmentally harmful practices, particularly in industrialised societies. Citizens therefore require adequate knowledge and awareness to address contemporary environmental challenges such as climate change, biodiversity loss, excessive resource exploitation, plastic pollution, and emerging environmental risks.
Education for Sustainable Development (ESD) and Science Communication (SC) have been recognised as essential tools for promoting environmental literacy and encouraging more sustainable practices [3]. Previous studies suggest that although individuals frequently demonstrate positive attitudes and knowledge regarding environmental issues, these do not necessarily translate into behavioural change [4]. Human behaviour often remains resistant to change, even when environmental risks are widely recognised. Moreover, modern urban and industrial lifestyles may weaken the individual's connection with the natural world, reducing opportunities for developing stronger environmental awareness.
In this context, natural parks and SC centres may play a relevant role by creating opportunities for reconnecting individuals with nature and fostering experiences that encourage environmental learning and behavioural transformation. The Gaia Biological Park (Parque Biológico de Gaia – PBG), the first permanent environmental education centre established in Portugal, appears to have evolved into a space promoting ESD and implementing SC activities designed to increase environmental awareness and encourage pro-environmental actions.
Considering the potential role of natural parks as agents of sustainability promotion, this study aims to explore institutional perceptions regarding the contribution of the Gaia Biological Park (PBG) to SD. Specifically, it seeks to understand how institutional actors perceive the role of SC activities in promoting sustainability practices and environmental citizenship.

1.1 Environmental Education and Education for Sustainable Development

The discussion surrounding the relationship between environmental limits and human development has evolved considerably over the past decades. Early concerns regarding the capacity of Earth's finite resources to sustain continuous population growth emerged with the Malthusian population theory, which suggested that population growth could eventually exceed the availability of natural resources [5,6]. Subsequently, global environmental concerns intensified during the twentieth century, particularly following the publication of *The Limits to Growth* by the Club of Rome in 1972, which highlighted the potential consequences of unrestricted economic and demographic expansion.
The same year, the United Nations Conference on the Human Environment held in Stockholm represented a turning point in international environmental policy, promoting a closer relationship between environmental concerns and development processes [7]. However, the concept of Sustainable Development (SD) only gained broader international recognition through the report *Our Common Future*, published by the World Commission on Environment and Development (WCED), where SD was defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (CMMAD, [8], p. 46).
This understanding of SD was further strengthened through international initiatives such as Agenda 21, the Millennium Development Goals (MDGs), and later the SDGs integrated into the 2030 Agenda (United Nations, 2015). The SDGs introduced an integrated framework addressing environmental, social, and economic dimensions while promoting collective responsibility towards a more sustainable future.
Within this context, education has increasingly been recognised as a fundamental mechanism for achieving sustainability. Initially, Environmental Education (EE) focused primarily on ecological issues and environmental awareness. Over time, however, broader perspectives emerged, incorporating social, economic, and cultural dimensions into educational approaches. This evolution led to the development of ESD, formally introduced through international discussions promoted by UNESCO [3].
The emergence of ESD generated considerable debate among researchers and educators. Some scholars argued that ESD represented a continuation and expansion of EE, while others questioned the replacement of EE terminology, arguing that EE had already incorporated social and environmental dimensions [9,10,11,12]. Despite these discussions, ESD gradually became established as a broader educational paradigm, aiming to equip individuals with the knowledge, competencies, values, and critical thinking skills necessary to address complex sustainability challenges.
According to UNESCO [3], ESD is characterised by an interdisciplinary perspective, lifelong learning principles, contextual relevance, and participatory educational practices. Furthermore, ESD seeks to empower individuals and communities to make informed decisions and adopt sustainable lifestyles capable of contributing to long-term societal transformation.

Current perspectives increasingly consider ESD as an evolutionary stage of EE rather than a replacement of it [13]. Consequently, education plays a central role in developing sustainability competencies and fostering active citizenship, becoming an essential pathway towards achieving the SDGs and promoting societal change.

1.2 Science Communication and the Promotion of Pro-environmental Behaviours

SC has progressively evolved from traditional deficit-based models, centred primarily on the transmission of scientific information, towards more participatory and interactive approaches that emphasise dialogue and public engagement. Earlier perspectives such as *Public Understanding of Science* (PUS) focused mainly on increasing scientific knowledge among citizens, assuming that higher levels of knowledge would naturally lead to more informed decisions and behavioural change. More recent approaches, including *Public Engagement with Science and Technology* (PEST), recognise that communication processes should involve interaction, participation, and co-construction of knowledge between scientific institutions and society [14,15].

Within the context of SD, SC has become increasingly relevant as a mechanism for enhancing environmental literacy and encouraging active citizenship practices. Beyond merely disseminating information, SC may contribute to the development of critical thinking skills, environmental awareness, and greater public participation in sustainability-related issues. Effective communication strategies can therefore support individuals in understanding complex environmental challenges and motivate them to adopt behaviours that contribute to sustainability goals.

However, previous research suggests that increasing scientific knowledge alone does not necessarily result in behavioural transformation. Knowledge and positive attitudes towards environmental issues frequently coexist with limited behavioural action, highlighting the existence of a gap between awareness and actual practice [4]. Consequently, SC initiatives increasingly seek to provide more experiential, participatory, and contextualised learning opportunities capable of influencing both cognitive and affective dimensions associated with environmental action.

Natural parks and non-formal educational environments may offer particularly favourable conditions for these approaches because they facilitate direct contact with nature and allow visitors to engage with real-world environmental contexts. Such spaces can create meaningful experiences that strengthen emotional connections with the environment while simultaneously fostering scientific understanding and promoting sustainable behaviours. Research has demonstrated that direct interaction with natural environments may positively influence environmental attitudes and strengthen individuals' willingness to engage in conservation practices [16].

In this regard, the PBG represents a relevant example of a SC environment that combines EE, biodiversity conservation, and non-formal learning experiences. Through activities specifically designed to engage diverse audiences, the Park creates opportunities for visitors to develop knowledge and awareness regarding sustainability issues while encouraging reflection about everyday environmental practices.

Considering the growing recognition of SC as a potential catalyst for behavioural change, the present study examines the role of PBG activities in promoting pro-environmental behaviours for SD. Specifically, the study seeks to understand whether SC initiatives implemented within a natural park context can contribute to influencing visitors' knowledge, attitudes, and behavioural intentions towards sustainability.

2. Methodology

This study adopted a qualitative case study approach to explore institutional perceptions regarding the contribution of the PBG to the promotion of Sustainable Development (SD). The case study design was considered appropriate as it enables an in-depth understanding of a contemporary phenomenon within its real-life context and facilitates the examination of participants' experiences and perspectives.

Data collection was conducted through semi-structured interviews with directors from the Department of Environment and Urban Parks (DAPU) of the Municipality of Vila Nova de Gaia. Semi-structured interviews were selected because they allow flexibility during data collection while ensuring that predefined themes relevant to the research objectives are addressed. The interview script included questions focusing on participants' perceptions of the Park's role in promoting SD, its contribution to the SDGs, institutional articulation and governance, and the potential impact of SC activities on environmental awareness and citizenship practices.

The study sample comprised three directors (n = 3), corresponding to 60.0% of the department's leadership positions. Participants were selected based on their direct involvement in the management, planning, and implementation of activities developed within the Gaia Biological Park, ensuring that they possessed relevant institutional knowledge and decision-making experience.
Data analysis followed a qualitative content analysis approach. Interview responses were transcribed, coded, and organised into thematic categories previously established according to the study objectives and interview structure. The analysis process aimed to identify recurrent patterns, shared perspectives, and institutional understandings concerning the role of the Park as a local sustainability agent.
This methodological approach enabled a detailed examination of institutional viewpoints and provided insights into how SC activities developed within a natural park context may contribute to strengthening environmental literacy and promoting SD practices.

2.1 Sample Characterisation

The study sample comprised three directors (n=3) from the Department of Environment and Urban Parks (DAPU) of the Municipality of Vila Nova de Gaia (Portugal), representing 60.0% of the department's leadership structure. Participants were selected through purposive sampling based on their direct involvement in the management, planning, and implementation of activities developed within the Gaia Biological Park (PBG).
The inclusion of participants occupying leadership positions was considered particularly relevant because of their institutional responsibilities and strategic roles in decision-making processes associated with environmental management, educational initiatives, and sustainability-related activities. Their professional experience and organisational responsibilities provided a comprehensive institutional perspective regarding the role of the Park in promoting SD and implementing SC initiatives.
The sample aimed to ensure access to informed perspectives concerning the Park's educational, environmental, and governance dimensions, allowing an in-depth exploration of institutional perceptions regarding the contribution of PBG to sustainability promotion and environmental citizenship practices.

2.2 Data Collection Instrument

Data were collected using a semi-structured interview guide specifically designed according to the objectives of the study. Semi-structured interviews were selected because they provide a balance between consistency across participants and flexibility for exploring emerging topics and obtaining deeper insights into participants' perspectives.
The interview guide included open-ended questions organised into thematic dimensions related to the role of the Gaia Biological Park (PBG) in promoting SD. Specifically, the questions explored: (i) participants' perceptions regarding the contribution of PBG activities to Sustainable Development; (ii) the relationship between park activities and the SDGs; (iii) the contribution of the Park to environmental awareness and environmental literacy; (iv) institutional articulation and governance processes; and (v) perspectives regarding the continuity and future development of sustainability-related initiatives.
The structure of the interview guide aimed to ensure that all participants addressed the same central themes while allowing opportunities for clarification, additional explanations, and the emergence of new relevant issues throughout the interview process. This approach facilitated the collection of rich qualitative data and enabled a more comprehensive understanding of institutional perceptions regarding the Park's contribution to sustainability promotion.

2.3 Procedure and Ethical Considerations

The interviews were conducted individually with the selected participants at previously agreed times and locations, ensuring suitable conditions for discussion and minimising external influences on the interview process. Prior to data collection, participants received information regarding the aims and procedures of the study and were informed about the intended use of the collected data.
Ethical principles guiding research involving human participants were strictly followed throughout the study. Participation was entirely voluntary, and informed consent was obtained from all participants before the interviews were conducted. Participants were informed of their right to withdraw from the study at any stage without any consequences. To ensure privacy and protect participants' identities, anonymity and confidentiality procedures were implemented during all stages of the research process. Personal identifiers were removed from interview transcripts and participants were assigned codes during data analysis and reporting procedures. All collected information was treated confidentially and

used exclusively for research purposes. Following participants' consent, interviews were recorded to ensure the accuracy and completeness of the collected information. The recordings were subsequently transcribed and prepared for content analysis through coding and categorisation procedures aligned with the research objectives.

2.4 Data Analysis

The interview data were analysed using qualitative content analysis, allowing for the systematic identification, organisation, and interpretation of recurring themes emerging from participants' responses. This approach was selected because it enables the examination of meanings, perceptions, and patterns within textual data while preserving the contextual richness of participants' narratives.
Following the interviews, audio recordings were transcribed verbatim to ensure an accurate representation of participants' statements. The transcribed material was then subjected to a coding process based on predefined analytical categories established according to the study objectives and the thematic dimensions included in the interview guide. These categories addressed aspects such as perceptions of SD, the contribution of the Gaia Biological Park (PBG) to the SDGs, environmental literacy, institutional governance, and future perspectives regarding park activities.
Subsequently, responses were grouped into thematic units and analysed to identify common patterns, similarities, and differences across participants' perspectives. Frequency analysis of recurring themes was also considered to support the interpretation of institutional perceptions and provide a clearer understanding of the relevance attributed to different dimensions of sustainability promotion.
The analytical process aimed to ensure consistency and coherence in data interpretation, enabling a comprehensive understanding of the institutional role of the Gaia Biological Park as a local agent contributing to SD and environmental citizenship practices.

3. Results and Discussion

The interview findings revealed a strong institutional consensus regarding the role of the Gaia Biological Park (PBG) as a strategic space for promoting Sustainable Development (SD). All participants (n = 3; 100.0%) considered that the activities developed by the PBG are predominantly associated with SC, recognising its role in making scientific knowledge accessible and meaningful for different audiences. Although participants acknowledged characteristics associated with both formal and non-formal educational approaches, they identified SC as the dimension that most strongly characterises the Park's initiatives.
One participant emphasised this perspective by stating that the Park seeks to "reach the public with the more complex aspects of science and make science simple" (P1). This statement suggests an understanding of SC as a process extending beyond the transmission of information and involving the adaptation of scientific knowledge to different audiences and contexts. Contemporary approaches to SC increasingly emphasise participation, accessibility, and dialogue rather than one-directional dissemination models. Within this perspective, natural parks may act as mediating environments where individuals engage directly with scientific knowledge through experiential and contextualised activities.
The findings also indicate that participants perceive PBG as a space capable of fostering environmental awareness and promoting more meaningful interactions between society and environmental issues. Previous research suggests that direct contact with natural environments may strengthen emotional attachment to nature and contribute positively to the development of pro-environmental attitudes and behaviours. Consequently, SC activities implemented in natural settings may provide opportunities not only for increasing knowledge but also for encouraging behavioural reflection and environmental responsibility.
Regarding the contribution of PBG activities to the SDGs, results indicate that all interviewees (n = 3; 100.0%) demonstrated familiarity with the SDGs and recognised their integration within the Park's activities. Participants identified SDG 4 (*Quality Education*), SDG 11 (*Sustainable Cities and Communities*), SDG 12 (*Responsible Consumption and Production*), and SDG 15 (*Life on Land*) as the goals most strongly represented within educational and environmental initiatives developed at the Park, mentioned by two participants (n = 2; 66.6%). One participant (n = 1; 33.3%) additionally highlighted SDG 13 (*Climate Action*) as an important dimension associated with Park activities.
These findings suggest that institutional actors perceive the Park as contributing to sustainability through an integrated and multidimensional perspective, extending beyond traditional biodiversity conservation practices. Rather than focusing exclusively on ecological preservation, participants recognised educational, social, and behavioural dimensions associated with sustainability promotion. Such

perceptions align with ESD principles, which advocate interdisciplinary approaches capable of integrating environmental, social, and economic dimensions while promoting active citizenship and critical thinking.
The interviews also highlighted the relevance of governance and institutional collaboration mechanisms for ensuring the effectiveness and continuity of sustainability initiatives. Results reveal that all participants (n = 3; 100.0%) stressed the importance of strengthening cooperation among municipal departments and establishing partnerships involving universities, private organisations, and local communities. Participants additionally emphasised the importance of implementing strategic planning instruments capable of ensuring the long-term continuity and development of Park activities.
The emphasis placed on collaboration suggests that participants recognise sustainability promotion as a multidimensional process requiring coordinated actions across different institutional actors. Previous studies have identified collaborative governance structures as important mechanisms for improving the effectiveness and societal impact of educational and environmental programmes. The present findings therefore indicate that the perceived impact of the PBG does not rely solely on activities conducted within the Park itself but also on broader institutional networks capable of strengthening its educational and social role.
Participants also demonstrated optimistic perceptions regarding the continuity of Park activities despite possible political or administrative changes. All interviewees (n = 3; 100.0%) considered that the PBG possesses a sufficiently established institutional identity to maintain its mission and activities over time. This perception may indicate that the Park is viewed not simply as an isolated municipal initiative but rather as an institution with a recognised educational and environmental identity embedded within the local community.
The data indicate that the Gaia Biological Park is institutionally recognised as a relevant local agent for sustainability promotion, contributing to environmental literacy, visitor diversification, and the reinforcement of territorial identity associated with environmental conservation and educational practices. Furthermore, the results reinforce the potential of natural parks as strategic instruments for local governance and support the role of SC as a mechanism capable of promoting environmental awareness and strengthening sustainability-oriented citizenship practices. The prominence of SDG 4 is unsurprising considering the educational mission of PBG. However, the simultaneous identification of SDGs related to urban sustainability, responsible consumption, and biodiversity conservation suggests that participants perceive the Park as contributing to sustainability through interconnected dimensions rather than isolated environmental actions.

4. Conclusion

This study explored institutional perceptions regarding the role of the Gaia Biological Park (PBG) in promoting Sustainable Development (SD), focusing on the perspectives of directors from the Department of Environment and Urban Parks of the Municipality of Vila Nova de Gaia. The findings revealed a strong consensus among participants concerning the relevance of the Park as a local agent for sustainability promotion and as a space capable of connecting EE, SC, and active citizenship practices.
Interviewees consistently recognised SC as one of the main characteristics of the activities developed within the Park, highlighting its capacity to translate scientific knowledge into accessible experiences for diverse audiences. Participants also demonstrated familiarity with the SDGs and identified several goals associated with Park activities, particularly SDG 4 (*Quality Education*), SDG 11 (*Sustainable Cities and Communities*), SDG 12 (*Responsible Consumption and Production*), and SDG 15 (*Life on Land*). These findings suggest that institutional actors perceive the Park as contributing to sustainability through an integrated and multidimensional perspective.
The results further emphasised the importance of institutional collaboration, strategic planning, and governance mechanisms for ensuring the continuity and effectiveness of sustainability initiatives. Partnerships among municipal departments, educational institutions, and local communities were recognised as essential factors for strengthening the social impact of Park activities and increasing their contribution to local sustainability objectives.
Although the study provides valuable insights into institutional perspectives regarding the contribution of PBG to SD, some limitations should be acknowledged. The reduced sample size and the exclusive focus on institutional actors limit the generalisation of findings. Future studies may expand the analysis by incorporating perspectives from visitors, educators, and other stakeholders involved in Park activities.

The findings reinforce the potential of natural parks as strategic instruments for local sustainability governance and highlight the importance of SC as a mechanism for promoting environmental literacy and encouraging behaviours aligned with SD principles.

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A Systematic Literature Review Mapping Evidence on Generative AI, Self-Directed Learning and Open Education

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Abstract

Generative AI (GenAI) is reshaping education. It influences how learners access knowledge, create content and receive feedback. At the same time, Open Educational Resources (OER) and Open Educational Practices (OEP) continue to expand opportunities for equitable access and the co-creation of knowledge. The importance of self-directed learning (SDL) has become even more crucial in an educational context that is constantly changing due to innovations such as GenAI and open education. Yet the links between GenAI, SDL, and open education are not well consolidated across recent scholarship. Facilitators and institutions face uncertainty about what is known, what is contested and where the gaps in the research lie. This paper presents a systematic literature review (SLR) of peer-reviewed journal articles and book chapters published between 2022 and 2026 that examine the relationships among GenAI, SDL and open education. Following a Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) approach, searches were conducted across major education and interdisciplinary databases using a systematic search strategy. After screening 425 initially identified texts, 11 texts were included in the final corpus and coded using ATLAS.ti. Data analysis involved thematic analysis, identifying recurring patterns related to the concepts of the study. The review mapped how GenAI is conceptualised in relation to SDL and how OER and OEP are positioned in GenAI-enabled learning environments. The findings suggest that GenAI may support SDL and open education through feedback, explanations, personalised support, OER adaptation and co-creation. However, the corpus also highlights risks related to overdependence, inaccurate outputs, hallucinations, bias, academic integrity, weak contextualisation, licensing, attribution and quality assurance. The paper contributes a synthesis of emerging evidence and proposes implications for teaching practice, OER design and policy guidance in GenAI-rich open learning environments.

Keywords: *Generative artificial intelligence (GenAI), self-directed learning (SDL), open educational resources (OER), open educational practices (OEP), systematic literature review, learner agency.*

1. Background and Motivation

Generative artificial intelligence (GenAI) is changing how users access information, generate text [1], receive feedback [2] and engage with open educational resources [3]. These developments create opportunities for personalised learning, feedback and resource adaptation, but also raise concerns about accuracy, bias, academic integrity and overdependence.

These matters are particularly relevant to open education. Open education emphasises access, sharing, adaptation and co-creation [4]. In principle, GenAI may support open education by assisting with the revision, remixing, localisation and adaptation of OER. However, GenAI does not automatically strengthen openness. Questions about licensing, attribution, transparency and quality assurance complicate its relationship with open education [5]. Self-directed learning (SDL) is central to this discussion. In GenAI-rich and open learning environments, SDL requires learners to identify learning needs, select appropriate tools, evaluate information, monitor progress and make informed decisions. Li et al. [6] describe ChatGPT-integrated SDL as an iterative process of planning, monitoring, adapting and evaluating learning, while [7] emphasise the need for learners to critically evaluate information in AI-saturated environments. This means that critical thinking, AI literacy, ethical awareness and reflective judgement become central to SDL. Although GenAI can support SDL through feedback, explanations, learning pathways and resource recommendations, it may also weaken SDL if learners become dependent on AI-generated outputs. Navas Bonilla and colleagues specifically warn that excessive AI use may reduce autonomy, critical thinking and independent decision-making [8].

The relationship between GenAI, SDL and open education is still emerging and is still quite fragmented due to the newness of GenAI in the academic space. A systematic review of these concepts is needed

to map what has already been researched, what is known and where the gaps in the literature remain. The main research question that is explored in this paper is: *What evidence exists on the relationship between GenAI, SDL and open education?*

2. Conceptual and Theoretical Framework

2.1 Generative AI in Education

Artificial intelligence (AI) is no new phenomenon. Generative AI has attracted worldwide attention with the release of Chat Generative Pre-trained Transformer (ChatGPT) in late 2022 [9]. Since then, several large language models and GenAI tools have become visible in education, including ChatGPT, Claude, DeepSeek, Microsoft Copilot, Google Gemini and DALL·E. Generative AI can generate human-like multimodal content such as text, audio, images and video [9]. This has brought both challenges and opportunities in various fields [9; 10], including education.
Generative AI has assumed different roles in the education space, such as that of a tool [11], a learning partner [12], a tutor system [13], a means of providing feedback [14], a content generator [15] and assistant to adapt resources [3]. These roles indicate that GenAI operates along a spectrum of support. It may assist with producing, adapting and organising learning materials, while also supporting more personalised and responsive forms of engagement.

2.2 Self-directed Learning

Self-directed learning is described by Knowles [16] as a "process in which individuals take the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies, and evaluating learning outcomes" (p. 18). This definition remains useful because it foregrounds learner responsibility, goal setting, resource identification, strategy selection and evaluation. In the context of GenAI, SDL becomes even more crucial than before because students need to exercise even more agency in these environments. Students need to find relevant information, decide which technology tools are suitable, reliable and appropriate, evaluate their outcomes and know how to integrate this into their learning process [6]. Because GenAI is prone to bias, errors and weak contextualisation, students must now apply critical thinking more rigorously than ever. They need to interrogate the accuracy, relevance and trustworthiness of AI-generated material. Li and colleagues [17] highlight hallucinations and inaccuracies as major challenges, while Ma et al. [7] contend that students must critically appraise information in an AI-permeated environment. GenAI thus demands greater SDL, yet it can also undermine SDL if students become overly reliant on AI outputs.

2.3 Open Education

Open education is described in broad terms in the literature and extends beyond only the use of open educational resources (OER). It is associated with learning innovations and learning quality [18], using resources, tools and practices to improve access to education [19]. The Cape Town Open Education Declaration [20] also presents open education as broader than OER, including open technologies, collaborative learning, flexible learning and the sharing of teaching practices. Stracke's [18] definition presents the quality-oriented dimension by describing open education as follows: "Open Education is designing, realising, and evaluating learning opportunities with visionary, operational, and legal openness to improve learning quality for the learners" (p. 184). This definition is useful because it links openness with design, implementation, evaluation and learning quality. Open education is therefore not only about making content available, but also about how learning opportunities are created, adapted, shared and improved.
OER remain central to open education because they support reuse, revision, remixing, redistribution and retention. However, open education also includes OEP. Cronin [21] defines OEP as "practices that include the creation, use and reuse of open educational resources (OER) as well as open pedagogies and the open sharing of teaching practices" (p. 18). For this paper, open education is understood as an educational approach that uses open resources, technologies and practices to widen access, support adaptation, encourage collaboration and improve learning quality.

2.4 Integrating to A Conceptual Framework

There is a mutual relationship between these concepts. Generative AI may support open education by helping facilitators and learners revise, remix and localise OER. It may support SDL by assisting with feedback, finding resources, planning and self-evaluation. So too, open education may support more responsible GenAI use. Tlili et al. [3] contend that OER can help mitigate hallucinations by providing AI systems with openly licensed educational materials that have been created, updated, or adapted by subject-matter experts and facilitators. This review is guided by the assumption that GenAI, SDL and open education intersect around the need for self-directed, critical and ethical learning.

3. Research Design and Methodology

Interpretivist approaches are “useful in understanding the subjective experiences, social phenomena, and complex human interactions” [22] (p. 2314). This study is located within an interpretivist paradigm because it seeks to understand how the selected texts conceptualise and report the relationship between GenAI, SDL and open education. The purpose was not to measure the effectiveness of GenAI, but to interpret patterns, meanings and relationships across the coded corpus.
A qualitative systematic literature review (SLR) was used to identify, screen, code and synthesise peer-reviewed literature related to the main topic under investigation. An SLR is a method used to locate, assess, and integrate all existing studies that are relevant to a specific research question, subject area, or phenomenon of interest [23; 24]. Scholars describe different ways in which an SLR can be conducted, but most acknowledge that certain steps or phases take place in the process [25]. These phases include formulating research questions and inclusion criteria [24], searching, screening and selecting texts [26], data extraction and coding [27] and synthesising the findings.
In this study, the texts were obtained from established databases, including Scopus, ScienceDirect, and Web of Science. Different variations of keywords such as “self-directed learning”, “generative AI” and “open education” were used in the searches. The study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework [28]. Figure 1 presents the PRISMA flow diagram for this study.

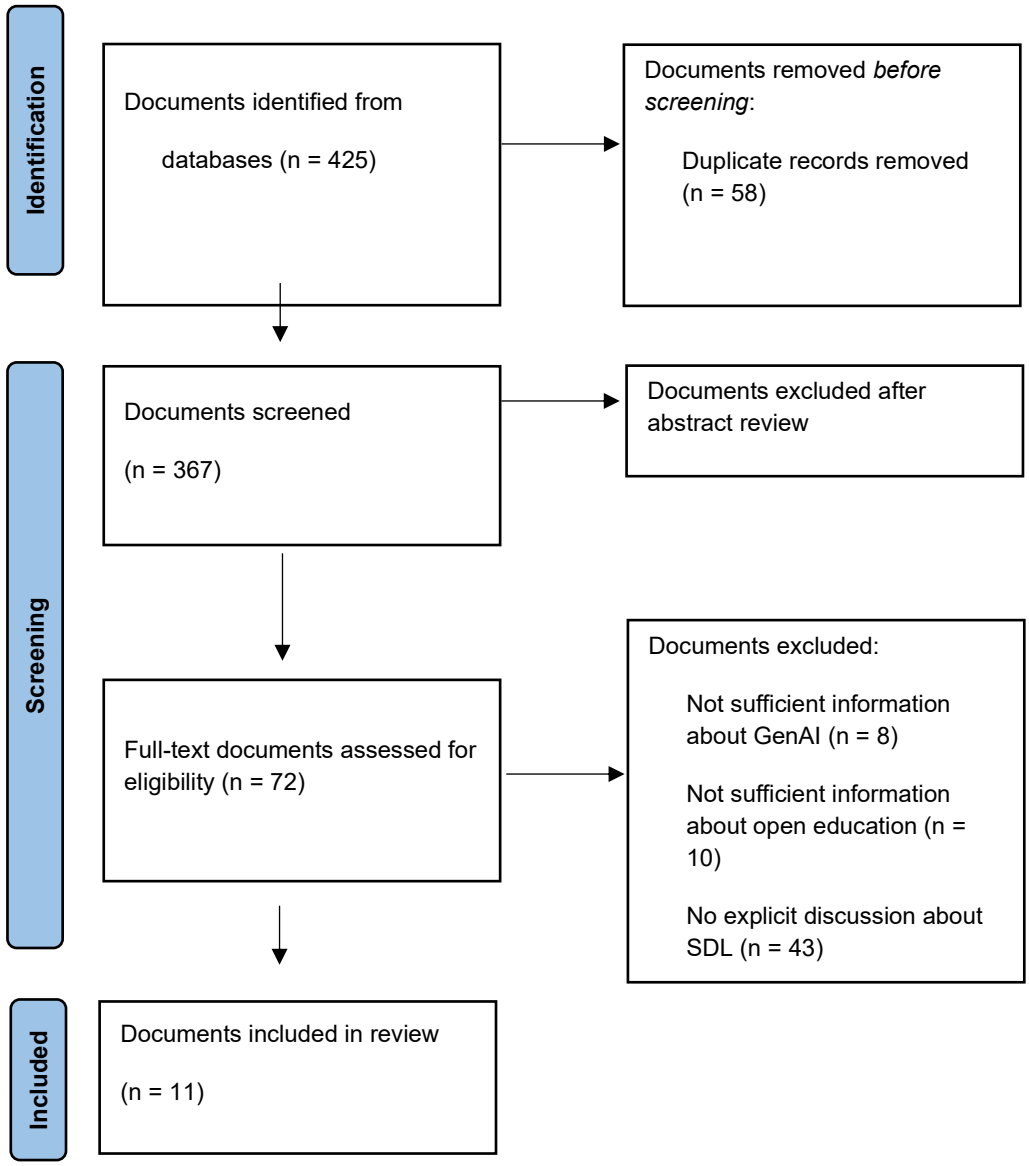


Fig. 1. PRISMA flow diagram of this study

The inclusion criteria focused on texts that were i) peer-reviewed book chapters and research articles, ii) publications dated from 2022 to 2026; iii) texts which specifically discuss all three main themes (SDL, open education and GenAI); iv) English texts; and v) review papers, conceptual work and empirical research. Eleven texts resulted from the search and screening process, which were coded and analysed using ATLAS.ti. A total of 425 texts were identified in the initial searches. After unsuitable texts and duplicate records were removed, 11 texts remained for coding.

A thematic analysis approach was used to categorise the selected texts using the six-phase process outlined by [29]. This process allows the researcher to identify and report recurring themes from the qualitative data and thereby provides insight into the topic under study. Inductive coding was used to discover emerging themes while coding the texts [30]. The findings and discussion that emerged from the review follow in the next section.

4. Findings and Discussion

4.1 Profile of the Corpus: Research Designs, Data Sources and Contexts

The corpus reflects a variety of methodologies. As illustrated in Table 1, the coded texts are situated mainly in higher education, open and distance learning, online language learning and open education contexts. The corpus includes formal educational settings, such as Sri Lankan state universities and a

South African ODeL university, and more open digital learning spaces, such as YouTube-based language learning communities.

Table 1. Profile of the corpus

Text	Research design	Data sources	Educational context
Ahmadfart [31]	Structured literature review and thematic synthesis	Database search and reviewed literature	Open education Interactive open educational resources (iOER)
Biyiri et al. [32]	Quantitative, deductive survey study	Online questionnaire; 627 undergraduate responses	Sri Lankan state universities
Bosch and Kruger [33]	Conceptual paper	Literature-based conceptual discussion	SDL, student agency and AI chatbots as OER
Bunt and Bunt [34]	Analytical autoethnography	Reflection on the design of *Prosper*	Sustainability education Game-based learning
Laubscher et al. [35]	Theory-synthesis	Literature-based synthesis	OEP, 4IR and SDL
Li et al. [6]	Qualitative phenomenological study	Interviews with 19 YouTubers who are experienced, self-directed language learners	Self-directed language learning (SDLL)
Li et al. [17]	Qualitative study	Semi-structured interviews were conducted with 14 facilitators of online language courses	Online language facilitators
Maphalala [36]	Qualitative phenomenological study	Interviews with four academics and focus group discussions involving ten fourth-year BEd students	South African ODeL
Navas Bonilla et al. [8]	PRISMA-based systematic review	Scopus and Web of Science; 77 studies	AI and SDL
Ruiz-Rojas and Acosta-Vargas [37]	Qualitative exploratory study	Interviews, observation and student-created artefacts	MOOC development
Tlili et al. [5]	Scenario and conceptual contribution	OEP-based scenarios	Open education and GenAI

Table 1 shows that the corpus includes review-based, conceptual, qualitative and quantitative contributions. Review-based texts, such as Ahmadfard [31] and Navas Bonilla et al. [8], provide broader mappings of iOER, AI and SDL. Conceptual and theory-synthesis texts, such as Bosch and Kruger [33], Laubscher et al. [35], and Tlili et al. [25], help clarify the relationships between SDL, OER, OEP, AI and digital transformation. The qualitative studies provide insight into participant experiences, while Biyiri et al. [32] offer survey-based evidence on undergraduate acceptance and use of ChatGPT for SDL.
The data collection methods also varied. They included structured database searches, online questionnaires, semi-structured interviews, focus groups, observations and student-created artefacts. This variety of data sources provides a broad evidence base for this review. However, the most common data source is that of reviews, conceptual work, perception-based studies and exploratory qualitative research. There is less evidence of longitudinal studies or sustained observation of actual GenAI-supported SDL practices over time. Also, the limited number of quantitative studies shapes the nature of the evidence presented in this review. This suggests that the field is still developing and that future research should move beyond perceptions and conceptual arguments towards studies that examine how learners and facilitators use GenAI in practice.

4.2 Conceptual Links Between Generative AI, Self-Directed Learning and Open Education

Due to the inclusion criteria, the corpus does not present GenAI, SDL and open education as isolated concepts. Instead, the texts show several points of connection. Open education is framed as more than access to resources alone. Ahmadfard [31] positions iOER as “a next-generation direction” (p. 1) within open education, where openly licensed resources include interactive features such as “simulations, branching scenarios, formative assessments, feedback mechanisms and adaptive digital features” (p. 2). These shifts open education from the dissemination of content towards more purposeful instructional design. Bosch and Kruger [33] also connect OER to access, adaptation and sharing, while Laubscher

et al. [35] emphasise that OEP and SDL connect strongly where learners become active co-creators of knowledge.
Bosch and Kruger [33] refer to Knowles' definition of SDL. They further associate SDL with initiative, independence, persistence, self-discipline, curiosity and confidence. They also argue that learners need opportunities to make choices about what and how they learn. Bunt and Bunt [34] link SDL to "autonomy, exploration and ownership of learning" (p. 37) in the design of the educational game *Prosper*. Li et al. [6] place SDL in the context of ChatGPT use, arguing that learners can explore the tool, experiment with conversational strategies and evaluate whether it supports their learning goals.
The strongest conceptual connection across the corpus is learner agency. Bosch and Kruger [33] clearly portray the relationship between SDL, OER, and AI as an environment in which learners are able to co-create learning materials, define their own objectives, and actively design their educational experiences. Ahmadfard [31] similarly argues that GenAI can enhance open pedagogy when it is woven into learning activities that require reflection and learner agency. Tlili et al. [5] extend this idea by arguing that OEP can support the safe and effective adoption of GenAI. Their contribution is important because it does not only ask how GenAI can enhance open education, but also how open education can enhance GenAI use. GenAI may support SDL and open education when it strengthens learner agency, participation, reflection and responsible use. However, it may undermine these aims when it is used merely to generate answers or when learners become dependent on automated outputs.

4.3 Roles and Capabilities of Generative AI Tools

The corpus presents GenAI as a multifunctional educational tool. Ahmadfard [31] describes GenAI as useful for drafting content quickly, translation, summarising and adapting OER while remaining sensitive to the context. This matters in open education because fixed resources are frequently difficult to adapt for local contexts, revise, customise, or integrate into more complex pedagogical designs. In this sense, GenAI is used as a tool for both the creation and adaptation of resources.
ChatGPT is the most commonly used GenAI tool in the corpus. Biyiri et al. [32] investigated university students' acceptance and use of ChatGPT for SDL. They reported that performance expectancy and social influence shaped their behavioural intention. They also found that both behavioural intention and facilitating conditions determined students' actual use. Navas Bonilla et al. [8] also identify ChatGPT as the most widely used conversational assistant in the studies they reviewed. They explain this by pointing to its ease of use, broad range of applications, and consistent, well-structured answers.
The corpus further shows that GenAI tools support several learning processes. Navas Bonilla et al. [8] identify several learning processes into which GenAI has been incorporated. These processes include feedback, tutoring and mentoring, assessment and self-assessment, learning design, practical application, and research and exploration. Maphalala [36] reports that AI tools in ODeL settings supported personalised feedback, the finding of resources, increased engagement, language development and self-evaluation. In that study, ChatGPT and Notion AI were used for writing support, content clarification, note organisation, feedback and the summarising of content.
GenAI also appears as a tool for open pedagogy. Tlili and colleagues [5] suggest that teachers and students collaboratively write prompts, run them, evaluate the outputs and compile the prompts as OER. This is a practical example of how GenAI, SDL and open education connect with each other. Learners are not simply consuming AI-generated responses. They are participating in prompt development, evaluation and sharing. Tlili et al. [5] also propose the construction of an OER-based GPT model, where evidence-based information from OER could be integrated into a more directed system that can be updated over time.
The reported benefits in the corpus, therefore include personalisation, feedback, learner agency, collaboration, inclusivity, participation, adaptation and co-creation. Ahmadfard [31] indicates that iOER can foster learner agency, collaboration, and inclusivity by means of interactive elements, adaptive technologies, multimedia resources, and integrated assessment tools. Biyiri et al. [32] add that because younger students are more technologically adaptable, they might not experience ease of use as a major barrier to ChatGPT adoption.

4.4 Challenges and Tensions

The corpus also reports several challenges that complicate the relationship between GenAI, SDL and open education. Regarding open education, Ahmadfard [31] observes that traditional OER have enhanced both access and affordability, yet their static format tends to constrain learner engagement, adaptability, and personalisation. The move toward iOER addresses this constraint, but also brings new

challenges, such as ensuring digital access, institutional preparedness, and faculty development. Institutional capacity is a recurring concern. Ahmadfard [31] reports that the development of high-quality interactive materials requires expertise in the creation of content, instructional design, programming and graphics. This may lead to substantial development expenses and added complexity, especially for institutions that have limited resources. Bosch and Kruger [33] also identify facilitator-related challenges, including different levels of proficiency in the use of technology, possible misalignment with pedagogical principles and limited awareness of AI capabilities. They also mention ethical and privacy concerns and the need for professional development in these areas.

The GenAI-related challenges are closely linked to SDL. Navas Bonilla et al. [8] warn that overreliance on AI has a negative impact on learner autonomy and critical thinking. These authors also assert that the dependence on technology can lead to cognitive overload and could cause students to become disconnected from their own learning process. They also note that when students delegate their decision-making to algorithms, this may limit their ability to "develop independent judgement, initiative, and creativity" (p. 14). Maphalala [36] reports similar concerns in the ODeL context, where participants raised issues of over-dependence, academic dishonesty, unreliable AI-generated information and reduced social interaction and critical thinking.

Reliability is another important challenge. Li et al. [17] report that hallucinations and inaccuracies are problematic in language learning because learners may encounter incorrect factual information or wrong explanations of the language system. The same text also notes that AI-generated content can be monotonous, repetitive and lacking in cultural or linguistic specificity. These findings suggest that GenAI can only support SDL if learners develop the capacity to question and verify AI outputs.

The corpus also raises concerns about openness itself. Tlili et al. [5] caution against "open-washing" (p. 406), where a tool is said to be open while still being based on restricted access and private profit. This is important for open education because free access is not the same as openness. Openness also requires transparency, adaptability, reuse, participation and collaboration.

4.5 Recommendations and Future Research Directions

The recommendations in the corpus emphasise that GenAI-supported SDL and open education require intentional, ethical and human-centred implementation. Ahmadfard [31] argues that realising the potential of iOER requires institutional investment, the training of facilitators and the development of scalable infrastructure. The same text also stresses the need to address digital equity, especially access to devices and connectivity. Maphalala [36] likewise advocates for well-defined institutional policies and support systems to promote fair access and ensure digital preparedness.

AI literacy is another recurring recommendation. Tlili et al. [5] argue that teachers should introduce the responsible use of GenAI before integrating it into learning activities. Li et al. [6] describe prompt engineering as a strategy that can enable learners to use ChatGPT more effectively in support of SDL. Across these texts, learners need support to use GenAI critically, responsibly and purposefully. Open pedagogy is also recommended as a practical way to integrate GenAI, SDL and open education. Tlili et al. [5] suggest that teachers and students can co-develop prompts, assess GenAI outputs and share prompts as OER. This positions learners as active participants in the teaching and learning process. It also links AI literacy to open knowledge creation.

The corpus further recommends collaboration and quality assurance. Ahmadfard [31] emphasises the importance of ongoing feedback from both teachers and students, as well as cooperation between subject-matter experts, instructional designers, and media professionals. Tlili et al. [5] recommend collaboration across fields such as computer science, psychology and design. These recommendations suggest that GenAI-supported open education cannot be left to individual facilitators or learners alone. It requires coordinated institutional and interdisciplinary support.

Future research suggestions in the corpus confirm that the field is still developing. Ahmadfard [31] notes that the research base remains fragmented, with many studies being discipline-specific, small-scale or limited in methodological rigour. Biyiri et al. [32] call for qualitative research on students' experiences and perceptions of ChatGPT to support SDL. Maphalala [36] advocates using larger, more heterogeneous samples that span various disciplines, institutions, and educational stages. He recommends further research on structured AI literacy programmes for students and staff, as these programmes can foster critical thinking and collaborative learning. Li et al. [6] recommend triangulating data with observations of learners' SDL processes and conducting longitudinal studies on the long-term impact of AI-integrated SDL.

The future research directions also point to the need for more context-sensitive work. Navas Bonilla et al. [8] recommend research across educational levels, disciplines and cultural contexts. Maphalala [36]

explicitly highlights the necessity for models that account for AI-mediated SDL within digitally unequal environments, particularly in regions like the Global South. Overall, the corpus suggests that future research should move beyond tool adoption and examine how GenAI, SDL and open education can be integrated in ways that are ethical, inclusive, pedagogically sound and responsive to context.

4. Conclusion

This systematic literature review mapped evidence on the relationship between GenAI, SDL and open education. The corpus shows that GenAI may support SDL through feedback, explanations, resource discovery, learning planning and personalised support. It may also support open education by assisting with the revision, remixing, localisation and adaptation of OER. However, the relationship is not automatically positive. The corpus also highlights risks related to overdependence, inaccurate outputs, hallucinations, bias, academic integrity, weak contextualisation, licensing, attribution and quality assurance. These risks are especially important because SDL depends on learner agency, critical thinking, reflection and informed decision-making. The review therefore suggests that GenAI can contribute to SDL in open education when it is used ethically, critically and in pedagogically sound ways. Its value depends on AI literacy, facilitator guidance, institutional support, digital equity and quality assurance. Future research should move beyond tool adoption and examine how learners and facilitators use GenAI in practice, especially in diverse and digitally unequal contexts.

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Epistemic Asymmetry in Adolescent Democratic Deliberation: Teacher Facilitation, Participatory System Design, and Initial Role Reconfiguration Insights from the SAUFEX Interdemocracy Pilot

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Abstract

This conceptual paper examines the rationale and preliminary pilot outcomes of the educational dimension of the Horizon-funded EU project SAUFEX, which seeks to democratize and decentralize decision-making processes related to Foreign Information Manipulation and Interference (FIMI). It argues that the inclusion of non-state experts alone is insufficient for democratization, as meaningful responsiveness to citizens and implementability of policies require structured public participation beyond expert advisory mechanisms. Drawing on diverse theories, the paper conceptualizes the conditions under which broad participation can contribute to resilience rather than devolve into illiberal or purely procedural forms of democracy. It contends that educational institutions provide a uniquely suitable environment for approximating these conditions, both logistically and normatively, through synchronized participation, cognitive diversity, and early democratic socialization. The paper presents Interdemocracy as a didactical framework through which adolescents can participate in structured consultation while developing citizen skills. A core challenge in adolescent democratic deliberation is epistemic asymmetry between teachers and students, which risks distorting authentic student participation. In response, Interdemocracy reconceptualizes the teacher's role from epistemic lead to non-epistemic facilitator of procedural integrity, student self-realization, and student self-correction.

Keywords: *facilitation, democratic deliberation, participation, epistemic asymmetry, autopoiesis*

Introduction

The Horizon-funded EU project SAUFEX has two broad aims. The first is to standardize and expand understanding of Foreign Information Manipulation and Interference (FIMI); the second is to decentralize and democratize decision-making processes and quality assurance related to FIMI. While the first aim is primarily technological, the second incorporates an educational dimension. This conceptual paper examines the rationale underlying the educational component and explores its implications. While educational institutions provide a promising setting for participatory democratic experimentation, they are structurally marked by epistemic asymmetry: teachers occupy institutionally sanctioned positions of epistemic authority, while student contributions are typically treated as epistemically subordinate. This asymmetry creates a tension between educational hierarchy and democratic participation.

The project's focus on education emerged through a gradual and incremental process. It developed from the formal inclusion of non-state experts in decision-making procedures. The mechanism chosen for this inclusion was the so-called "Resilience Council" [1], an institution designed to enable representatives from NGOs and academia to contribute their expertise across all phases of governmental FIMI management - from detection, classification, grading, and reporting to the formulation of responses. The first formal Resilience Council was established to advise the Polish Minister of Foreign Affairs, and a second is planned as an advisory body to the forthcoming Polish DSC. While the inclusion of non-state experts constitutes a step toward the decentralization of decision-making processes and quality assurance, it remains an initial step only. By focusing exclusively on expert participation, Resilience Councils do not facilitate the inclusion of the general public. As such, they fall short of increasing state institutions' responsiveness to citizens – a key democratic feature [2] - and therefore do not reduce the risk of undemocratic liberalism, a paternalistic tendency within liberal democracies that prioritizes institutions and procedures over citizen well-being [2]. Indeed, limiting participation to experts may instead reinforce a meritocratic bias, whereby the existing hierarchical status quo is viewed as the morally justified endproduct of education and effort [3]. Thus, rather than

broadly advancing decentralization and democratization, stopping at this first step would risk merely confirming existing patterns of exclusion while extending participation to a limited cohort only.

Participation

Setting up participatory processes seems straightforward. Besides establishing how much influence the participants should have, as measured on Arnstein's ladder, the big choice seems to be whether to use a representative method of participation (in which representatives are selected by vote or by lottery) or a referendum-style mechanism. There is a caveat though: participation without a focus on the well-being of all of its participants could turn into a potentially rigged zero-sum game in which the end goal is exerting influence. Decision-making in that scenario, in its ultimate form, risks devolving into a Hobbesian-style contest over influence and democracy risks being seen as a mechanism for allocating influence only. In the case of undemocratic liberalism, democracy as procedural frame becomes an intrinsic good in itself, whereas under illiberal democracy – responsiveness to the in-group citizenry as defined by populist criteria - outweighs the importance of procedures and democratic institutions [2] - it becomes contingent and instrumental. In neither case does the well-being of the whole of the general public constitute the central normative commitment.

Participation Conceptualization

To involve the whole of the general public in fair decision-making means concretely conceptualizing the engagement of not just experts or an in-group as well as positioning citizen well-being as a frame.
Lewandowsky et al. [7] provide a starting-point for conceptualizing citizen engagement. He distinguishes two discourses that are essential in a democracy: "fact-speaking" and "belief-speaking". While "fact-speaking" establishes accuracy as the correspondence between an opinion and evidence gathered in the external world, "belief-speaking" prioritizes accuracy between an opinion and one's inner world. Although "fact-speaking" may excel in getting the facts right and creating a shared understanding of reality, "belief-speaking" is essential for the implementability of policies – without public support evidence-informed decision cannot be effective. This does not mean that the general public should be seen as incapable of fact-speaking; rather the take-away is that both discourse types should be covered by participation mechanisms. Limiting participation to experts and focusing on "fact-speaking" misses out on an essential discourse type thereby risking turning participation into a top-down instrument.
Surowiecki [8] supplies the conditions under which "wisdom" rather than herd folly can be extracted from a crowd. His key insight is that when individual perspectives are aggregated correctly, crowds consistently outperform even knowledgeable individuals across three types of problems: cognition, coordination, and cooperation. For individual perspectives to be aggregated viably, participants need at least some relevant information about the subject. In addition, according to him, there are three preconditions to be met. The first precondition is diversity, understood not in sociological terms, but in conceptual and cognitive terms. Suitable crowds need to encompass a range of perspectives among their participants. The second precondition requires independence in thinking. Participants must make decisions without interference from others: there is to be no communication among individuals, no negotiation, and no compromising during the process of formulating their perspectives. The third precondition emphasizes decentralization. Individuals should draw on their local, specific knowledge and tacit understanding.
In Saufex, citizen well-being is positioned as an intrinsic system quality relevant in the context of information distortions: resilience. Citizen well-being is conceptualized as the experience of autonomy, belonging, and achievement [4]. If these experiences are absent or near absent, a state of dislocation occurs [5]. This condition is so excruciatingly painful that those experiencing it "become susceptible to the lure of pills, gang leaders, extremist religions, or violent political movements – anybody and anything that promises relief" [6]. Resilience in this state is minimal, rendering democracy vulnerable to external and internal destructive pressures.
The underlying image of citizens in this view is autopoietic - autopoiesis is used here in an applied sense to denote that citizens maintain, realize, and correct themselves within a context provided. If the context is destructive and leads them into dislocation, they adapt by self-correction. The same holds good for contexts that enhance their experience of autonomy, belonging, and achievement.

Education

With the conceptualizations in place, the question is: what does this have to do with education? The answer is partially logistical: implementing Surowiecki's second precondition presents significant challenges. In order to prevent consultation between participants when presenting their perspectives, a setting must be created in which a crowd of citizens receives a question simultaneously and responds individually, without an opportunity for discussion or coordination. In order to approximate Surowiecki's preconditions, including the second one, a carefully designed process is needed.
Currently in project Saufex, it is not clear yet how to translate the preconditions into a setting suitable for the whole of the general public. However, for at least one group a potentially compatible setting does exist adolescents within the educational system. Relative to many other administratively available cohorts, educational settings provide substantial cognitive diversity. They also offer an obvious frame for introducing relevant subject information. And, importantly, its central planning allows for simultaneously presenting a question to a cohort. In addition to logistical feasibility, the educational setting also provides a normative advantage: by providing a constructive context by enabling young citizens to experience structured democratic engagement, it allows democratic participation skills to be developed early. Yet the very institutional structure that makes schools logistically suitable for synchronized participation also introduces a complication: educational settings are organized around entrenched epistemic asymmetries between teachers and students, requiring procedural safeguards if authentic student expression is to be preserved.

Interdemocracy

Within project Saufex a promising didactical intervention was identified: Interdemocracy. Interdemocracy is an established didactical format and method. The format was recommended by the European Commission in its original *Guidelines for teachers and educators on tackling disinformation and promoting digital literacy through education and training* (2022). The implementation of the format and method was endorsed by the European Commission in the *Final report* of the Commission expert group on tackling disinformation and promoting digital literacy through education and training. Prominent representatives across diverse professional communities, including policy-makers, academics, and practitioners, positively reviewed a book on Interdemocracy's format and method and its theoretical foundations [9], while Interdemocracy pilots were positively vetted by representatives of the Polish Ministry of Foreign Affairs and the Pomeranian Center for Teacher Education.
Interdemocracy is seen as promising since it enables the distillation of wisdom from groups within a participatory process as well as individual autopoiesis – autonomous self-realization and self-correction. It stipulates a context in which all individuals autonomously formulate their perspectives on one central question simultaneously in parallel, without interaction.

The Interdemocracy Participation Process

The Interdemocracy participation process is designed to operationalize large-scale citizen input while preserving the conditions necessary for independent judgment and meaningful aggregation of perspectives. The method structures participation across multiple classrooms in parallel in several stages that combine autonomous individual input, collective reflection, and institutional response.
The process starts with a short, evidence-informed introduction by the teacher in the classroom followed up by a central question that is directed to students. Each student then formulates an individual response. The responses are submitted directly to a central server, ensuring that contributions are recorded simultaneously and independently. Once collected, the responses are analyzed transparently through an artificial intelligence system operating under human supervision. The system clusters similar responses and identifies recurring themes in the students' perspectives. This clustering does not replace human judgment but assists in organizing large volumes of input in a transparent and manageable way. To avoid potential bias multiple clustering procedures are followed including two-step digital content forking.
On the basis of the clustered responses, a group of older students, referred to as the Youth Resilience Council, develops a set of preliminary recommendations. The Council performs bounded deliberation constrained by aggregated student input and subject to iterative student ratification; it operates as a translating layer that structures the aggregated input into policy-relevant recommendations. It reviews the aggregated perspectives of the participating students and formulates proposals that reflect the concerns, arguments, and values expressed in the responses. The recommendations are then returned

to the participating students for evaluation. These students, in turn, indicate whether they agree or disagree with the proposed recommendations and provide a short explanation for their position. These reflections are submitted to the central server. The second round of student input is subsequently analyzed using the same AI-supported clustering process under human supervision. The resulting analysis allows the Youth Resilience Council to assess how the broader group of students perceives the proposed recommendations and whether important concerns or perspectives have been overlooked. Based on this feedback, the council considers whether revisions are necessary and, if required, adjusts the recommendations accordingly. After this deliberative step, the council formulates the final set of recommendations. The final recommendations are then transmitted to relevant public institutions, which are invited to respond to them. The institutional responses are communicated back to the participating students, closing the feedback loop and ensuring that participants are informed about how their contributions have been received and what potential impact they have had.
Through this structured process, Interdemocracy seeks to combine independent individual input, large-scale aggregation of perspectives, youth deliberation, and institutional accountability within a single participatory framework. Adolescents are not taken as proxies for the general public; they only give voice to their own age cohort. Therefore, this set-up presents not more than a first step in engaging all citizens.

The Interdemocracy Autopoiesis Process

Alongside the participation mechanism, Interdemocracy incorporates a structured process designed to regulate how communication takes place during the classroom participation stages. The aim of this process is to create conditions in which participants can articulate their views independently while experiencing attentive listening and exposure to multiple perspectives. Within the framework, the teacher assumes a strictly procedural role as facilitator. The teacher does not evaluate the content of students' contributions or intervene in the substance of the perspectives uttered. Instead, their responsibility is limited to ensuring that the communication directives governing the process are correctly implemented and followed.
Several communication directives structure the process. First, students are required to formulate their perspectives using first-person statements. Each participant expresses their view from their own standpoint rather than speaking on behalf of others or in abstract generalizations. This requirement encourages personal responsibility for one's perspective and reduces the tendency to frame arguments in adversarial or groupish terms. Second, interaction among students is prohibited during the formulation of individual perspectives. Participants develop their responses independently, without discussion, negotiation, or coordination with others. This rule preserves independence in thinking and prevents the convergence of viewpoints through peer influence thus fulfilling Surowiecki's second precondition of independent judgment in raw input collection. Third, students formulate their perspectives in three successive steps. They first write their response on paper, then submit it in digital form, and finally read their statement aloud while recording it as an audio contribution. This sequence encourages reflection during formulation and personal responsibility when presenting perspectives publicly. Fourth, each spoken contribution must conclude with the phrase "thank you." This small procedural element functions as a symbolic closure of the statement and reinforces a respectful communication environment. Fifth, the order of read-out student contributions is determined randomly. Randomization prevents the emergence of implicit hierarchies in speaking order and ensures that no participant is structurally advantaged or disadvantaged in presenting their perspective. Sixth, responses to the perspectives of others are not permitted during this phase of the process. Students are expected to listen without commenting, challenging, or endorsing the statements of their peers. In line with this rule, the teacher maintains a neutral stance and refrains from evaluative reactions. Finally, all students are invited to participate in each activity under identical conditions. No participant is excluded from the process, and no individual receives preferential treatment. The procedural framework therefore ensures equal access to participation.
Together, these communication directives establish a stable and psychologically safe launchpad for participation. They encourage students to articulate their views more authentically, while also allowing them to experience that others listen with sustained attention. At the same time, participants are exposed to a range of different perspectives, fostering an experiential awareness of plural viewpoints within the group.

Interdemocracy and Student Autopoiesis

The independent articulation of their thoughts by students and the experience of being listened to by others without judgment in the Interdemocracy setting is to foster student self-realization. The exposure of students to plural perspectives formulated by their fellow-students is to foster student self-correction. A key challenge to student autopoiesis is the traditional epistemic asymmetry between teachers and students that hierarchically enforces student correction, rather than stimulates self-correction. This is a major reason why in Interdemocracy teachers assume a different role.

Teachers as Facilitators

Within Interdemocracy teachers fulfill the role of facilitators. This role is strikingly different from their regular role as teachers. As teachers, their basic task is to transfer curriculum-defined knowledge and skills to students; they function as subject-bound epistemic leads with a mission. Their focus is predominantly on "fact-speaking"; they impose the educational system as the default context for autopoiesis. This leads to benevolent interventions, aimed at nudging students towards a predefined subject-specific direction within the boundaries of the curriculum, while the teacher's inherent mission adds a layer of emotional care. At a cognitive level, this dynamic is underpinned by naïve realism: the implicit assumption that one's own perceptions and interpretations correspond directly to objective reality, while those of others are comparatively subjective or distorted. In the educational context, this cognitive tendency interacts with role-based authority to help produce an epistemic hierarchy in which teacher-speaking is tacitly construed as superior "fact-speaking," while student-speaking is more readily classified as inferior "fact-speaking" or mere "belief-speaking." Because teachers experience their own judgments as objective rather than interpretive, this classificatory process typically remains invisible to them. Consequently, interventions in student expression appear not as exercises of epistemic power, but as necessary and morally justified corrections. Naïve realism thus renders influence epistemically invisible to the influencer while making restraint feel like professional negligence.
The role of facilitator is based on very different requirements. The facilitator is to observe in an epistemically neutral fashion, not intervene benevolently. Their primary responsibility is to safeguard the procedural integrity of the process, ensuring that students can express their perspectives with minimal external barriers or constraints. The epistemic foundation is content-agnostic, not domain specific, whereas the boundaries are legal rather than the curriculum. Lastly, the teacher's mission is not to be translated into emotional care but into ethical care – as responsibility, not guardianship.

Teachers as Facilitators - Experiences

Between November 2025 and March 2026, a small-scale Interdemocracy pilot was conducted in ten primary schools in the Pomeranian Voivodship (Poland) within the framework of the Saufex project. Fourteen teachers conducted four ninety-minute sessions in sixteen classes. The pilot was co-organized with the Pomeranian Center for Teacher Education and was supported by the Polish Ministry of Foreign Affairs. It was anticipated that teachers would face significant challenges in fulfilling the facilitator role due to the profound shift in attitude it entails.
The pilot results did not confirm this expectation. Teachers quantitatively reported increasing comfort with the facilitator role across sessions. After sessions two, three, and four, teachers indicated on a Likert-5 scale how much they agreed with the following statement: *Compared to the previous session, I felt more comfortable in the role of facilitator*. The average results were positive. The average score was 4.17 after session 2; 3.8 after session 3; and 3.56 after session 4.
The quantitative results indicate that teachers continued to report increasing ease in facilitation across sessions, although the magnitude of perceived improvement diminished over time. Qualitative data offers insight into teachers' internal journey, suggesting that what appears as ease in practice may in fact reflect a deeper transformation in professional identity. Facilitators also reported noticeable shifts in their own professional experience during the sessions.
Many teachers described a sense of becoming "unburdened" during facilitation. Once they accepted that they were not expected to provide the correct answers or to resolve every situation, they were able to concentrate fully on maintaining the process itself. They reported feeling more at ease as they were no longer positioned as controllers of classroom outcomes. This change reduced their performance anxiety and allowed them to adopt a more observational role. Subsequently, teachers became more aware of underlying classroom dynamics. By stepping slightly aside from their usual authoritative role, they were able to observe patterns of peer influence, subtle social pressures, and individual strengths

of students who typically remain quiet in conventional lessons. Many facilitators also reported that guiding the process helped them further develop soft competencies, including mindfulness, conflict moderation, and emotional self-regulation.
At the same time, the shift in role occasionally proved challenging. In situations in which student engagement declined or in which participants expressed resistance, the facilitator's task was not to intervene or push the discussion toward a particular outcome but simply to maintain the communicative framework - ensuring time boundaries, procedural fairness, and a safe environment. Several teachers indicated that "guarding the frame" rather than attempting to produce immediate results required a different form of professional patience, and for many this represented the most demanding aspect of the transition into the facilitator role.

Other Types of Facilitation

While Interdemocracy facilitation in the classroom involves facilitating students to formulate their perspectives and listen to other students' perspectives without judgment or reaction, facilitation in the Youth Resilience Council concerns in addition what Bauman calls "citizen skills": "the skills of interaction with others – of conducting a dialogue, of negotiation, of gaining mutual understanding and of managing or resolving conflict". [10] This shifts the focus of facilitation even further towards an ethical care stance. [11; 12]
Within the Saufex project, deliberations are ongoing on how to apply facilitation to curriculum subjects that lean heavily on a teacher transfer of knowledge and skills. A preliminary option could be to devise a deterministic, policy-constrained AI system, compliant to all EU and national regulations, that dynamically generates exercises and provides first-line formative assessments. Teacher facilitation would then consist of providing second-line formative assessment support, helping students interpret the feedback, clarifying procedural misunderstandings, supporting metacognition and self-correction, and ensuring accessibility and legal and ethical compliance.

Conclusion

Within SAUFEX, the educational dimension of democratizing FIMI governance emerges not as an auxiliary component but as a practical and normative necessity. Educational settings provide an institutional environment suited for approximating the procedural conditions required for structured large-scale citizen participation while simultaneously cultivating some of the democratic competencies needed for future public engagement. Through Interdemocracy, schools appear capable of functioning not merely as sites of knowledge and skills transfer, but as safe environments in which adolescents practice independent thought and expression, experience plural perspectives, and participate in structured processes of collective voice formation. As such, education could function both as a mechanism for implementing participatory resilience-building and as a formative space for democratic socialization.
This potential reorientation carries significant implications for the professional role of teachers. Within the SAUFEX framework, facilitation is conceptualized not as a minor pedagogical adjustment but as a distinct professional stance requiring the temporary suspension of conventional epistemic authority in favor of procedural neutrality, ethical care, and frame-guarding. Early pilot findings suggest that teachers seem capable of adopting the role of facilitator and may experience it as professionally transformative although challenging. If facilitation is further extended into additional educational and curricular contexts, the teacher's role may increasingly evolve from knowledge and skills transmitter toward facilitator of student self-realization, self-correction, and democratic participation. Possibly, the educational strand of project SAUFEX could point not only toward new participatory mechanisms, but toward a broader reconceptualization of education and teacher professionalism in democratic societies.

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Market Resilience in Crisis: Post-Pandemic Enrollment Shifts and Sector-Based Performance in U.S. Higher Education, 2019–2024

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Abstract

The COVID-19 pandemic disrupted the traditional stability of the U.S. higher education market, exposing distinct vulnerabilities across different institutional types. Rather than a uniform decline, enrollment data from 2019–2024 reveal a fragmented landscape where student choice shifted significantly based on sector responsiveness. Using national enrollment percentage-change data drawn from the Integrated Postsecondary Education Data System (IPEDS), the analysis evaluates sector-specific differences and assesses whether institutional sector is significantly associated with changes in enrollment. Statistical methods, including ANOVA and non-parametric alternatives, are used to test the significance of observed differences. Both the categorical analysis (Chi-Square) and the continuous analysis (ANOVA) converge on the same finding: Institution Sector is a critical determinant of enrollment trends. The Chi-Square test reveals a strong dependency where PAB and Public 2-year sectors are disproportionately represented in the "Extreme Decrease" category, while private sectors dominate the "High Increase" category. Results indicate substantial variation across sectors, with for-profit institutions showing growth while public two-year and Public Associate-Dominant (PAB) institutions experienced the steepest declines. The study argues that for public institutions to recover, they must move beyond traditional enrollment management and integrate the more aggressive, consumer-oriented recruitment tactics utilized by their private competitors.

Keywords: *Post-Pandemic Enrollment Trends, Enrollment Strategy, Market Segmentation and Sectoral Inequality, Student Recruitment, Higher Education Marketing, Regional Divergence, Private Institutions, Public Institutions, Public Two-year Colleges.*

Introduction

The COVID-19 pandemic disrupted higher education globally, leading to shifts in student behavior, institutional operations, student recruitment and enrollment patterns. In the United States, early pandemic years saw widespread declines in undergraduate enrollment, particularly within community colleges and public institutions. As pandemic effects receded, questions emerged about long-term structural changes in enrollment by institutional sector.

This paper examines the post-pandemic effect of COVID-19 on U.S. student enrollment by institutional sector from 2019–2024. The goal is twofold: (1) to document sector-specific enrollment changes using descriptive analysis, and (2) to evaluate whether institutional sector is statistically associated with enrollment change.

Review of Literature

The COVID-19 pandemic caused unprecedented disruption in U.S. higher education, producing sharp enrollment declines across sectors from 2020–2022, followed by uneven regaining patterns since 2023. Research clearly shows sectoral disparities, leadership and policy challenges, and changing student preferences regarding flexible and career-oriented education. Several studies show that U.S. higher education enrollment dropped significantly during the pandemic. However, in fall 2024, undergraduate enrollment rates increased for the first time since before the pandemic. According to the National Student Clearinghouse Research Center (NSCRC), "Undergraduate enrollment increased across major institutional sectors, with community colleges (Public two-year and Public PABs) seeing the largest growth (+5.4%, +288,000)".

Enrollment Fluctuations and Recovery Dynamics

While the *Current Term Enrollment Estimates* (CTEE) show a macro-level "rebound" in total undergraduate enrollment for 2024, micro-level findings suggest that this recovery is fragile. Vaterlaus et al. (2024) indicated that “based on college student responses, pandemic recovery was a multidimensional process” and suggested that “future studies should also monitor how college student pandemic recovery changes over time”.
Earlier analysis by Carmean, Kil, and Baer (2021), utilizing data from 12.6 million students, confirmed that enrollment loss was concentrated in community colleges and regional public institutions. This was further supported by the NSCRC (2021), which provided regular updates on the widening gap in student success during the pandemic onset.

Sectoral Shifts and Long-Term Trends

Francis and Goodman (2025) utilized longitudinal data from Massachusetts—mirroring broader national trends—to examine enrollment patterns five years after the initial pandemic disruption. Their research challenges the assumption of a universal "return to normal," instead identifying "sustained effects" on both the size and demographic composition of the student body. They demonstrate a sustained sectoral shift; as of Fall 2024, they show that “relative to pre-pandemic trends, fall 2024 enrollment is down 2% in local public schools, up 16% in private schools, and up 50% in home schools”.
In California, Fairlie and Bulman (2022) explored how the pandemic impacted enrollment patterns and academic outcomes within the community college system, concluding that “enrollment changes were substantial across a wide range of fields and were large for both vocational courses and academic courses that can be transferred to four-year institutions”. Cummins (2025) later used system mapping in California to visualize these long-term educational pipeline effects, identifying a structural "post-pandemic onset" enrollment contraction driven by a confluence of demographic shifts and "pandemic-induced mobility" that has not reversed.

Structural Changes and the "Next Normal"

The post-pandemic classroom has also exposed deep inequities in access, digital readiness, and persistence, which Whitson and Brazeal (2022) argue have reshaped enrollment behaviors and expectations. As a result, scholars like Glantz et al. (2021) propose that the use of new practices and tools should take hold as changes to institutional procedures are incorporated into the "next normal".
Although final data on student enrollment for 2025 had not been published at the time of this research, initial estimates from the CTEE (2025) indicate that total postsecondary enrollment is up 3.2% in 2025 compared to 2024. While undergraduate enrollment grew to 15.3 million, it remains 2.4% below pre-pandemic levels. Conversely, graduate enrollment is now 7.2% higher than in 2020. Despite these gains, Schueler and Miller (2024) found substantial variation in public school and college enrollment in Virginia, suggesting that mobility patterns continue to affect higher education pipelines.

Method

Data Source

The Integrated Postsecondary Education Data System (IPEDS) is a system of 12 interrelated survey components conducted annually. It covers approximately 5,819 U.S. postsecondary institutions eligible for Title IV federal student aid and gathers data from every college, university, and technical and vocational institution that participates in federal student financial aid programs.

Variables

- **Dependent Variable:** Percentage change in student enrollment from 2019 to 2024.
- **Independent Variable:** Institutional sector, categorized as:
    - All Private, For-Profit Institutions
    - Private, Not-for-Profit, 4-year
    - All 4-year Institutions
    - All Private, Not-for-Profit Institutions
    - Public, 4-year

- Overall
- All Public Institutions
- Public PAB (primarily associate degree-granting baccalaureate institutions)
- All 2-year Institutions
- Public, 2-year
- All PAB Institutions

Statistical Approach

Descriptive Statistics - Enrollment data were derived from IPEDS, representing national enrollment counts by institutional sector for the years 2019 and 2024. The percentage changes in student enrollment for major institutional categories were calculated for each region. For each region, as well as at the national level, changes in student enrollment were analyzed by institutional sector to identify which sectors were most and least affected by the COVID-19 pandemic

Test of Significance - Because the dependent variable is continuous (percentage change) and the independent variable is categorical (institutional sector), an Analysis of Variance (ANOVA) was selected as the standard method for evaluating differences across multiple groups.

Two complementary statistical approaches were employed:

1. **Chi-Square Test of Independence:** To analyze the association between sector and categorical enrollment impact.
2. **Analysis of Variance (ANOVA):** To test for significant differences in mean percentage enrollment change.

Results

Analysis of Change in Student Enrollment by Institution Sector and Region National Overview (United States, 2019–2024)

Nationally, student enrollment in higher education declined by an overall 3.16% between 2019 and 2024. The disaggregated data reveal that public institutions experienced the sharpest declines (–4.71%), particularly within two-year colleges (–9.69%) and public programs of primarily associate degree-granting baccalaureate institutions (PABs) by –7.99%. By contrast, private for-profit institutions exhibited modest growth (+5.12%), suggesting that their flexible, online-oriented models may have absorbed some displaced students.

Across the four-year sector, enrollment remained relatively stable (+0.27% overall), masking divergent patterns between private not-for-profit four-year colleges (+0.36%) and public four-year universities (–0.72%). These figures indicate that while the U.S. higher education system is rebounding unevenly, institutional type remains a critical determinant of post-pandemic recovery, with for-profit providers emerging as net beneficiaries of shifting student preferences toward career-aligned and accessible learning pathways.

Table 1. Percentage Change in Student Enrollment — United States, 2019–2024

Institution Sector	% Change (2019–2024)
Overall	-3.16%
All 4-year Institutions	0.27%
All PAB Institutions	-10.61%
All 2-year Institutions	-9.18%
All Public Institutions	-4.71%
All Private, not-for-profit Institutions	0.17%
All Private, for-profit Institutions	5.12%
Public, 4-year	-0.72%
Private, not-for-profit, 4-year	0.36%
Public, PAB	-7.99%
Public, 2-year	-9.69%

Midwest Region

In the Midwest, enrollment declined more sharply than the national average, with an overall decrease of 4.46%. Public institutions experienced notable contractions (–4.69%), driven primarily by declines at two-year colleges (–4.94%) and public PAB institutions (–22.55%). Private institutions did not offset these losses, as both private not-for-profit (–5.10%) and for-profit (+1.54%) sectors posted weak or marginal growth.
The broad-based downturn in both public and private four-year institutions (–3.43%) may suggest that demographic stagnation and limited population growth in the Midwest have compounded the pandemic's impact. The Midwest thus reflects a pattern of institutional retrenchment and limited diversification, with community and applied institutions being particularly vulnerable.

Table 2. Percentage Change in Student Enrollment — Midwest Region, 2019–2024

Institution Sector	% Change (2019–2024)
Overall	-4.46%
All 4-year Institutions	-3.43%
All PAB Institutions	-26.04%
All 2-year Institutions	-4.97%
All Public Institutions	-4.69%
All Private, not-for-profit Institutions	-5.10%
All Private, for-profit Institutions	1.54%
Public, 4-year	-3.83%
Private, not-for-profit, 4-year	-4.12%
Public, PAB	-22.55%
Public, 2-year	-4.94%

Northeast Region

The Northeast shows the most severe enrollment contraction across all U.S. regions, with an overall decline of 4.46% but disproportionately large losses among public and two-year institutions. Specifically, public institutions fell by 10.83%, two-year colleges by 15.20%, and public PAB programs by an extraordinary 68.19%. In contrast, private not-for-profit institutions registered modest growth (+3.78% overall; +3.06% among four-year colleges), reflecting the region's strong concentration of elite and well-endowed universities capable of weathering enrollment volatility.
This sharp dichotomy underscores a deepening structural inequality between selective private universities and underfunded public systems in the Northeast, where demographic decline and rising tuition costs may further constrain access to public higher education.

Table 3. Percentage Change in Student Enrollment — Northeast Region, 2019–2024

Institution Sector	% Change (2019–2024)
Overall	-4.46%
All 4-year Institutions	-0.24%
All PAB Institutions	-45.99%
All 2-year Institutions	-15.20%
All Public Institutions	-10.83%
All Private, not-for-profit Institutions	3.78%
All Private, for-profit Institutions	-6.60%
Public, 4-year	-5.38%
Private, not-for-profit, 4-year	3.06%
Public, PAB	-68.19%

Institution Sector	% Change (2019–2024)
Public, 2-year	-15.54%

South Region

In the South region, enrollment trends are comparatively more stable, with only a 2.04% overall decrease—a smaller decline than in other regions. The four-year sector shows resilience, with both public and private not-for-profit universities posting modest gains (+1.72% and +3.05%, respectively). However, the two-year sector remains weak, showing a 10.44% overall decline, suggesting that the community-college pipeline remains fragile despite the region's strong population base. Public PAB institutions (–1.43%) and for-profit providers (–2.41%) also declined, albeit mildly.
The South's relative stability indicates regional resilience, likely supported by higher in-migration, population growth, and the strong presence of large state university systems that retained enrollment through hybrid and online options.

Table 4. Percentage Change in Student Enrollment — South Region, 2019–2024

Institution Sector	% Change (2019–2024)
Overall	-2.04%
All 4-year Institutions	2.36%
All PAB Institutions	-5.87%
All 2-year Institutions	-10.44%
All Public Institutions	-2.77%
All Private, not-for-profit Institutions	1.72%
All Private, for-profit Institutions	-2.41%
Public, 4-year	1.72%
Private, not-for-profit, 4-year	3.05%
Public, PAB	-1.43%
Public, 2-year	-10.31%

West Region

The Western region presents a mixed recovery, with an overall enrollment decline of 2.34%, but substantial growth in private for-profit institutions (+11.15%). This surge suggests that market-driven, online-oriented education providers capitalized on post-pandemic demand for flexible learning. Traditional institutions exhibited mild improvement, with public four-year universities (+1.62%) and private not-for-profit institutions (+1.24%) recovering slightly. Nonetheless, two-year institutions (–7.88%) and public PAB programs (–7.66%) experienced ongoing declines, reinforcing the nationwide trend of weakening enrollment in short-cycle education.
Overall, the West exemplifies a dual recovery trajectory—a modest rebound in four-year enrollment coupled with continued attrition in public and sub-baccalaureate programs.

Table 5. Percentage Change in Student Enrollment — West Region, 2019–2024

Institution Sector	% Change (2019–2024)
Overall	-2.34%
All 4-year Institutions	2.17%
All PAB Institutions	-8.19%
All 2-year Institutions	-7.88%
All Public Institutions	-4.32%
All Private, not-for-profit Institutions	1.24%
All Private, for-profit Institutions	11.15%

Institution Sector	% Change (2019–2024)
Public, 4-year	1.62%
Private, not-for-profit, 4-year	0.61%
Public, PAB	-7.66%
Public, 2-year	-9.64%

Comparative Regional Analysis

The regional breakdown confirms that the post-pandemic enrollment recovery in U.S. higher education has been geographically uneven. For-profit institutions recovered more strongly than any other sector, particularly in the West. Private not-for-profit universities displayed relative resilience in the Northeast and South. Conversely, public two-year institutions remain the most vulnerable nationwide, reflecting their dependence on in-person enrollment, local economies, and state funding structures. Primarily associate degree granting baccalaureate (PAB's) programs experienced sharp declines across all regions, indicating a contraction in career-technical education pathways
These findings point to a reconfiguration of the higher-education landscape, where private and market-oriented institutions are expanding their relative share of enrollment, while public two-year and PAB programs continue to bear the brunt of post-pandemic disruptions. The new landscape recognizes a new pattern of market segmentation and a clear need for innovative enrollment strategy by higher education institutions in the US.

Table 6. Comparative Regional Analysis of Enrollment Change

Region	Overall Enrollment Change	Strongest Sector	Weakest Sector
United States	–3.16%	Private, for-profit (+5.12%)	Public 2-year (–9.69%)
Midwest	–4.46%	Private, for-profit (+1.54%)	Public PAB (–26.04%)
Northeast	–6.60%	Private not-for-profit (+3.78%)	Public PAB (–68.19%)
South	–2.04%	Private, not-for-profit 4-year (+3.05%)	Public PAB (–10.44%)
West	–2.34%	Private, for-profit (+11.15%)	Public 2-year (–8.19%)

Testing the Relationship Between Sectoral Inequality and Regional Divergence

To investigate whether institutional sector is significantly associated with percentage change in enrollment, appropriate statistical tests must be selected based on data characteristics.

Association Between Sector and Enrollment Impact Categories

To examine the relationship between institution sector and student enrollment changes, data were analyzed across 11 distinct sectors and four U.S. regions. Two complementary statistical approaches were employed: a non-parametric analysis of enrollment impact categories and a parametric comparison of mean percentage changes.

Chi-Square Test of Independence

First, percentage changes in enrollment were recoded into a five-level ordinal measure of enrollment impact: *High Increase* (> +2%), *Mild Increase* (0% to +2%), *Mild Decrease* (0% to −5%), *Substantial Decrease* (−5% to −15%), and *Extreme Decrease* (< −15%).
A Chi-square test of independence was conducted to determine if the distribution of these impact categories differed by institution sector. The relation between these variables was significant, $\chi^2(40, N = 44) = 72.33$, $p = .001$. To assess the strength of this association, Cramer's V was calculated. The result indicated a very strong association ($V = .64$), suggesting that institution sector is a robust predictor of the severity of enrollment changes. Specifically, Public Bachelor's (PAB) and Public 2-year institutions

were disproportionately represented in the "Extreme Decrease" category, while Private For-Profit institutions appeared most frequently in the "High Increase" category.
This confirms that knowing the institution sector provides substantial predictive power regarding the severity of enrollment changes. Specifically, Public Bachelor's (PAB) and Public 2-year institutions were disproportionately represented in the "Extreme Decrease" category.

Analysis of Mean Enrollment Change (ANOVA)

A one-way analysis of variance (ANOVA) was conducted to test whether the mean percentage change in enrollment differed significantly by sector. Preliminary assumption testing revealed a violation of the normality assumption (Shapiro-Wilk, $W = .86$, $p < .001$), though homogeneity of variance was technically preserved (Levene's test $p = .052$).
Given the violation of normality, both Welch's ANOVA (robust to unequal variances) and the Kruskal-Wallis H test (non-parametric) were conducted alongside the standard ANOVA to ensure the validity of the results. All three tests confirmed a statistically significant difference in enrollment changes between sectors:

- **Standard ANOVA:** $F(10, 33) = 3.73$, $p = .002$
- **Welch's ANOVA:** $F(10, 10.9) = 3.05$, $p = .031$
- **Kruskal-Wallis:** $H(10) = 33.84$, $p < .001$

Post hoc comparisons using Tukey's HSD test indicated that the **All PAB Institutions** sector experienced significantly steeper declines ($M = -28.6\%$) compared to **All Private, For-Profit Institutions** ($p = .003$) and **Private, Not-for-Profit, 4-Year Institutions** ($p = .011$). These findings confirm that while private sectors generally maintained stability or slight growth, public 2-year and public bachelor's institutions faced severe enrollment contractions across all regions.
Both the categorical analysis (Chi-Square) and the continuous analysis (ANOVA) converge on the same finding: **Institution Sector is a critical determinant of enrollment trends.** The **Chi-Square test** reveals a strong dependency where PAB and Public 2-year sectors are disproportionately represented in the "Extreme Decrease" category, while private sectors dominate the "High Increase" category. The **ANOVA** confirms that these differences in mean enrollment change are statistically significant, driven primarily by the severe declines in Public Bachelor's and Public 2-year institutions.

Discussion and Conclusion

The post-pandemic enrollment landscape reveals a clear market segmentation across sectors. For-profit institutions recovered more strongly than any other sector, while public institutions—especially two-year and PAB institutions—suffered significant losses. The regional breakdown confirms that the post-pandemic enrollment recovery in U.S. higher education has been geographically uneven.
These findings underline a reconfiguration of the higher education landscape, where private and market-oriented institutions are expanding their relative share of enrollment, while public two-year and applied programs continue to bear the brunt of post-pandemic disruptions. Such pattern clearly requires reassessment of old enrollment strategy by higher education institutions in the US.

Conclusion

This study documents substantial sector-level variation in post-pandemic enrollment changes between 2019 and 2024. Two-year and PAB institutions absorbed the largest enrollment declines, reflecting their higher concentration of low-income, first-generation, and adult learners. In contrast, for-profit institutions may have leveraged flexible online offerings to attract displaced students.
These findings highlight a clear market segmentation and the deepening stratification of postsecondary opportunity in the post-pandemic era and underscore the need for differentiated enrollment strategy responses to support the sectors most adversely affected.
At the time of this writing (December 2025), the final enrollment figures for spring and fall 2025 had not been published by IPEDS. These figures are expected to be released in early 2026, which will require further analysis to confirm the findings of this study. Such analysis will strengthen the empirical foundation for sector-specific policy interventions aimed at enrollment recovery.

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Digital Travel Narratives and the Reconfiguration of Intercultural Competence in Higher Education

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Abstract

Travel narratives in times of contemporary digital culture are no longer confined to printed memoirs or documentary formats. They circulate constantly through social media platforms, blogs, vlogs, and algorithmically curated feeds, blending text, image, and video into immersive representations of place. For many students, these multimodal narratives, although fragmented, constitute their primary encounter with foreign cultures. The result is a subtle, but powerful transformation in the way cultural knowledge is produced, consumed, and internalized. What appears as a window onto global diversity may, in fact, operate as a mediated familiarity shaped by curated aesthetic filtering, selective framing, and platform logics that prioritise visibility over complexity. This paper considers the pedagogical implications of this shift. How should higher education respond to a context in which perceptions of cultural "others" are increasingly formed through curated, at times misleading, digital travel content? Drawing on Michael Byram's model of Intercultural Communicative Competence (1997), particularly the capacities of interpreting and relating and the dimension of critical cultural awareness, and engaging with Darla Deardorff's (2006) processual understanding of intercultural development, the paper argues that digital travel narratives demand a reconceptualization of intercultural pedagogy. Competence in this environment cannot be reduced to linguistic proficiency or exposure to diversity; it requires the ability to interrogate representation, to recognize subjectivity, and to situate oneself reflexively within systems of cultural meaning. Rather than treating digital narratives as supplementary teaching materials, the paper proposes approaching them as sites of critical analysis through which students can develop interpretive depth, reflexive awareness, and resistance to algorithmically reinforced stereotyping. In doing so, it contributes to ongoing debates on the future of intercultural education in an era where culture is increasingly encountered through screens and curated "representations" rather than lived experience.

Keywords: *Travel narrative, digital, higher education, intercultural competence*

1. Introduction

The digital shift has fundamentally transformed the conditions through which cultural knowledge is produced, encountered, and interpreted. The digital ecosystem, including Instagram reels, TikTok travel content, YouTube vlogs, blogs, and algorithmically, allow *users* to access, circulate, and engage with representations of places, communities and cultures at a scale and frequency of their own choosing, before ever having to physically cross an actual border. What all these processes share in common, is the lack of direct experience, direct observation and direct engagement with the subjects portrayed. For people, particularly young people, these highly curated and processed representations constitute a primary source of knowledge and "mediated" experience of foreign cultures, shaping their perceptions, and assumptions long before any direct intercultural interaction takes place. Recent studies from Pew Research Center (2025) indicate that social video consumption for news and information globally increased from 52% in 2020 to 65% in 2025, while 44% of young adults aged 18–24 identify social media and video platforms as their primary source of news and information [1], [2]. In this type of ecosystem, introduction with a particular culture is achieved through screens, where swiping and scrolling have substituted the actual physical processes of acquiring contextual depth and critical understanding [3].

This transition is taking place against a backdrop of expansion of travelling as a phenomenon, at an estimated 1.52 billion international tourist arrivals worldwide in 2025. In addition to marking the highest level ever recorded, it also marks a record in terms of digital travel content created and consumed, as well as fundamental changes in the way the actual experience of travel itself happens, and is subsequently portrayed in some literary form. Consumption of travelling as an experience and its almost instantaneous documentation happens fast, in what seems more a quest to *conquer by sight and visual*

documentation rather than understanding the visited subjects. Recent studies indicate that 83% of travellers use social media for travel inspiration, while travel-related content on TikTok alone has accumulated hundreds of billions of views through hashtags such as #travel and #travelvlog [5], [6]. This has a direct impact on cultural exchange, cultural knowledge and perception of cultural differences, as travel narratives, despite their form, have played an important role in mediating perceptions of cultural difference. From travel memoirs and literary accounts resulting from lengthy exposures and direct observation and engagement with the documented subjects, to documentaries and televised travel programs, representations of distant places have long contributed to how societies imagine and interpret cultural "others" [7] and to the emergence of public pedagogy.

In contrast, digital travel narratives differ significantly from the traditional travel writing earlier forms. Unlike the inherited body of travel literature, which was characterised by physical presence, engagement, observation and some form of processing or reflection, i.e. the case of Edit Durham's works or Margaret Hasluck, digital narratives circulate through fast-paced multimodal environments shaped by platform logics and algorithmic visibility [3], [8]. Documentations of cultural realities are presented in the form of processed images, short videos, and other curated products meant for instant consumption and sharing, carrying limited knowledge weight for the ones who consume it. As a result, representations of culture are frequently filtered through performative authenticity, selective framing, and visual simplification [9].

The implications apply to higher education in relation to intercultural education scholarship also. Existing approaches to intercultural competence have largely emerged from frameworks that prioritised direct interaction, mobility, dialogue, and immersion as the primary conditions through which intercultural understanding develops [10], [11]. Today, students approach intercultural encounters with already *influenced* views by what they have *consume*d digitally, giving rise to a conflict between what they perceive and what the context actually is. As Byram argues, intercultural competence requires not only knowledge of other cultures, but also "the ability to decentre and take up the perspective of another" [10].

From the intercultural education scholarship perspective, the challenge for higher education is therefore, no longer simply how to expose students to the inter-cultural discourse, but how to ensure critical interpretation of mediated representations through which cultural knowledge is generated and *consumed.* This is particularly important given that digital travel *content is* characterised by a sense of *proximity and familiarity* with the context, which does not necessarily correspond to deep understanding. Exposure to visual diversity alone does not automatically foster reflexivity, critical awareness, or the capacity to engage with cultural complexity. In some cases, repeated digital representations may even reinforce stereotypes, flatten differences, or encourage superficial forms of cultural consumption masked as intercultural openness [12].

This paper focuses on the pedagogical implications of this shift: how should higher education respond to a context in which perceptions of cultural "others" are increasingly formed through curated, at times misleading, digital travel content? Drawing on Michael Byram's model of Intercultural Communicative Competence [10], particularly the capacities of interpreting and relating and the dimension of critical cultural awareness, and engaging with Darla Deardorff's [11] processual understanding of intercultural development, the paper argues that digital travel narratives demand a reconceptualization of intercultural pedagogy. Competence in this environment cannot be reduced to linguistic proficiency or exposure to diversity; it requires the ability to interrogate representation, to recognize subjectivity, and to situate oneself reflexively within systems of cultural meaning.

Rather than treating digital narratives as supplementary teaching materials, the paper proposes approaching them as sites of critical analysis through which students can develop interpretive depth, reflexive awareness, and resistance to digitally reinforced stereotyping. In doing so, it contributes to ongoing debates on the future of intercultural education in an era where culture is increasingly encountered through screens and curated "representations" rather than lived experience.

2. Digital Travel Narratives and the Transformation of Cultural Mediation

Despite these transformations in modes of cultural encounter, the importance of intercultural competence cannot be disputed. To the contrary, the increased inter-cultural interactions has further accentuated the importance of better understanding cultures. Literature on intercultural competence has traditionally emphasised dialogue, immersion, direct engagement, and reflective interaction as central conditions for intercultural learning [10], [11]. Such frameworks generally assume that sustained exposure to cultural difference and the *observer's capacity* to critically observe and interpret unfamiliar contexts play a fundamental role in the development process of intercultural understanding. At the same

time, the role of travel narratives has been explored in relation to the shaping of public understandings of foreign cultures and its subsequent contribution to various forms of public pedagogy [7]. These approaches to intercultural competence, although differing in emphasis and disciplinary perspective, converge on a number of aspects.

According to Deardorff, intercultural competence refers to "the ability to communicate effectively and appropriately in intercultural situations based on one's intercultural knowledge, skills, and attitudes" [11]. Whereas Byram, furthers the definition on intercultural competence, focusing on the ability to interpret and relate cultural meanings, critically evaluate perspectives, and develop what he describes as "the ability to de-centre and take up the perspective of another" [10]. In exploring the concept through his *Developmental Model of Intercultural Sensitivity* framework, Bennet looks at intercultural competence as a developmental shift in the way individuals perceive and respond to cultural difference, moving from ethno-centric perspectives toward greater intercultural sensitivity and ethno-relativism [12]. What stands out is his emphasis on the importance of understanding foreign cultures relative to their own context rather than through the standards of one's own culture. Notes of ethnocentric perspectives are present in numerous travel narratives, such as in Lord Byron and John Cam Hobhouse depictions of Albania.

Kramsch identifies interpretation of symbolic meaning as crucial to intercultural understanding. She further argues that intercultural understanding requires the ability to interpret symbolic meaning and recognise the cultural positioning embedded within communicative practices [13], contrary to the digital travel narratives, where cultural, social and historical elements are presented as visual consumable cultural experiences, while their deeper symbolic meaning from a social or cultural perspective, remain unexplored. Similarly to Kramsch's approach to exploring meaning beyond what is obvious, Edward Hall also focuses on the understanding of

culture as a system of implicit meanings and hidden dimensions that extend beyond immediately observable behaviour [14]. For Hall, intercultural understanding is conditioned by one's ability to recognise the often-invisible structures that shape communication, social interaction, and perception, which would require in-depth observation, analysis and interpretation of the observed context.

Intercultural understanding is presented as a complex process requiring sustained observation, contextual interpretation, and reflection on multiple layers of meaning, including symbolic and implicit cultural dimensions [10], [11], [13], [14]. Across the various definitions, meaningful intercultural learning is conditioned by the ability to adopt an ethno-relativist approach and recognise layers of cultural meaning rooted in broader social, historical, and cultural contexts [12]. These competencies cannot be reduced to mere exposure, as they require interpretive depth, sustained interaction, reflexivity, and the capacity to engage with ambiguity and complexity in encounters with cultural difference [15], [16]. Contemporary digital travel environments increasingly challenge these preconditions, as they are characterised by fast-paced consumption, selective and fragmented representation, algorithmic mediation, and instant visibility.

These perspectives on intercultural competence highlight also how the contemporary digital environment conditions how these competences are formed and exercised. As travel narratives shift from elaborate and interpretative, to brief, primarily visual accounts based on short exposure to the foreign context, broader questions of observation, authority, authenticity, representation, and meaning-making arise. The following table summarises some of the major structural transformations characterising contemporary digital travel narratives and considers their implications for the development of intercultural competence.

Table 1. Structural Transformations in Digital Travel Narratives and Their Implications for Intercultural Competence

Dimension	**Classical Travel Narratives**	**Contemporary Digital Travel Narratives**	**Implications for Intercultural Competence**
Temporality	Extended embedding, slower observation, delayed narration and publication	Instant documentation, real-time sharing, accelerated circulation of experiences shaped by processes of "time-space compression" [17]	Reduced time for reflection, contextual interpretation, and gradual intercultural understanding

Narrative Structure	Linear, reflective, descriptive, and contextually grounded narratives	Fragmented, modular, multimodal, and non-linear forms of storytelling characteristic of digital narratives [18], [19]	Weakening of sustained interpretive engagement and coherent contextual understanding
Representation	Textually mediated interpretation emphasising explanation and contextualisation	Visually dominated and highly aestheticised representations shaped by simulation and spectacle [20], [21]	Increased visual familiarity without corresponding interpretive depth or symbolic understanding
Cultural Engagement	Direct observation, dialogue, immersion, and prolonged interaction with local communities	Accelerated symbolic consumption through short-form and algorithmically curated exposure	Reduced opportunities for reflexivity, ambiguity tolerance, and ethno-relativist interpretation [10], [12]
Symbolic Meaning	Attention to cultural context, symbolism, social relations, and historical interpretation	Simplification of cultural practices into consumable visual experiences detached from deeper symbolic meanings	Limited engagement with implicit meanings and deeper cultural logics [13], [14]
Authority and Knowledge Production	Authorial authority grounded in prolonged experience, linguistic engagement, and contextual observation	Authority increasingly dispersed across audiences, engagement metrics, platform visibility, and algorithmic circulation [3], [22]	Instability of interpretation and weakening of contextual reliability and epistemic depth
Authenticity	Search for contextual and experiential authenticity through immersion and interpretation	Curated, staged, and performative authenticity shaped by platform aesthetics and audience expectations [23]	Blurring of distinctions between lived experience and constructed representation
Audience Relationship	Readers positioned primarily as receivers of interpretation	Interactive audiences participating in circulation, validation, and meaning construction within participatory digital cultures [24]	Cultural meanings become fluid, unstable, and increasingly engagement-driven
Platform Logic	Narratives shaped primarily by authorial intention and editorial structure	Visibility determined by algorithms, virality, engagement metrics, and platform optimisation [3], [25]	Cultural exposure filtered through algorithmically reinforced visibility structures
Purpose and Orientation	Interpretation, contextualisation, documentation, and knowledge generation	Visibility, performance, audience engagement, and symbolic consumption increasingly prioritised within digital culture [21], [26]	Shift from intercultural interpretation toward performative interculturality
Pedagogical Implications	Supports slower observation, contextual learning, and interpretive intercultural engagement	Encourages rapid recognition, symbolic familiarity, and surface-level exposure	Necessitates critical digital literacy, reflexive interpretation, and critical engagement with representation [11], [27]

From the comparison, it becomes evident that the transformation is not simply about form, but about fundamental reshaping of the conditions through which intercultural understanding occurs. Classical travel narratives were generally characterised by extended, sustained observation and direct interaction with the local context, as opposed to digital travel narratives primarily relying on immediacy, visibility and curation. These transformations become particularly visible when comparing historical and contemporary representations of specific cultural contexts, such as Albania in British travel narratives across time.

3. Comparative Perspectives on Albania in Historical and Digital Travel Narratives

Albania represents a particularly relevant case through which to examine the transformation of travel narratives and their implications for intercultural understanding. Historically approached as a remote, unfamiliar and culturally different, Albania attracted numerous travel writers including including Lord Byron, John Cam Hobhouse, Edith Durham, and Margaret Hasluck, whose works contributed significantly to the production and circulation of knowledge about Albanian society within broader European audiences [7]. They generally relied on prolonged observation, embedding in the local context, direct and sustained interaction with local communities, and analytical reflection in constructing their narratives. Contemporary digital representations of Albania, by contrast, increasingly emerge through accelerated and visually mediated environments structured by platform visibility, aesthetic circulation, and audience engagement.

Observation vs Visibility

Historical travel narratives on Albania frequently emerged from extended engagement with the local context. Durham's accounts, for example, relied on prolonged interaction with communities, detailed observation of customs and social structures, and attempts to interpret symbolic dimensions of everyday life. Hasluck similarly engaged with language, folklore, and customary law as means of understanding Albanian society beyond surface appearance. Contemporary digital travel narratives, however, increasingly privilege visibility over observation. Much contemporary travel content presents Albania through rapidly consumable visual markers including beaches, mountains, hospitality rituals, affordability, and "hidden gem" aesthetics circulated through blogs, destination platforms, reels, and short-form travel narratives [28], [29], [30], [31].
Interpretation vs Symbolic Consumption
While classical travel writers frequently attempted to contextualise the cultural and historical dimensions of Albanian society, contemporary digital narratives often reduce cultural practices to symbolic consumable experiences. Hospitality, food traditions, mountain life, affordability, Riviera tourism, and local customs are frequently presented as aesthetic and emotionally engaging visual fragments detached from broader historical or social interpretation [28], [29], [30], [32], [33]. Contemporary representations of Albania increasingly rely on recurring visual and symbolic motifs such as "Europe's last hidden gem", "the Maldives of Europe", inexpensive coastal tourism, and "untouched" landscapes circulated through blogs, travel platforms, and international media coverage. Consequently, digital familiarity with Albania may develop through repetition of symbolic imagery rather than through deeper engagement with cultural complexity.

Duration vs Acceleration

The temporal conditions under which representations are produced have also changed substantially. Historical travel writing often emerged through journeys lasting months or years, allowing writers time for observation, reflection, contextual immersion, and interpretive processing. Durham, Hasluck, Byron, and Hobhouse spent extended periods travelling through and observing Albanian territories, producing narratives grounded in prolonged engagement with local communities and everyday life. Contemporary travel narratives, by contrast, are increasingly produced in real time within accelerated digital environments that reward immediacy, novelty, and rapid circulation [17]. Much contemporary travel content on Albania is structured around short-term and highly consumable experiences, including "weekend escapes", Riviera tourism, affordability, visual landscapes, and rapidly circulating destination recommendations shared through blogs and digital travel platforms [28], [29], [30], [31]. Under such conditions, travel becomes simultaneously an experience and a performative act of documentation, limiting opportunities for the slower interpretive processes associated with intercultural understanding. The comparison between historical and contemporary travel narratives on Albania therefore illustrates

broader transformations in the conditions through which cultural knowledge is produced and consumed. While classical travel writing was often grounded in prolonged observation, interpretive narration, and contextual engagement, contemporary digital representations increasingly privilege visibility, immediacy, aestheticisation, and symbolic accessibility. This transformation does not necessarily eliminate intercultural exposure, but it fundamentally alters the depth, temporality, and interpretive conditions through which intercultural understanding is formed. Rather than encouraging sustained engagement with cultural complexity, many contemporary travel narratives operate through accelerated visual familiarity and emotionally accessible representations designed for circulation within digital attention economies.

Conclusion

This paper examined how the concept of intercultural competence in relation to higher education has transformed as a result of the digital shift. Intercultural competence frameworks from numerous researchers were analysed, including Byram, Deardorff, Bennett, Kramsch, and Hall, helping identify a number of elements associated with traditional intercultural learning, such as sustained direct observation, interpretation of symbolic and implicit meanings, and engagement with the local context. Through the analysis of contemporary digital narratives, it became evident that conditions under intercultural learning happens, including noticeably shorter periods of time to observe, engage and interpret, a tendency to share visual, at times processed representations of the intercultural experience. The paper used a comparative analysis approach to identify how the transformations of the conditions impact not only travel narratives, but most importantly intercultural understanding and the knowledge production process. The differences between traditional travel writing and digital narratives are evident with the traditional approach particularly favouring elements of depth of understanding and interpretation, the search for symbolic or implicit meanings and attempts to contextualise the unfamiliar. The paper argued that exposure to a foreign context alone does not produce intercultural understanding or meaning, giving rise to narratives that remain detached from their historical context, social complexity, and interpretive depth.

The paper used a comparative analysis approach to identify how the transformations of the conditions impact not only travel narratives, but most importantly intercultural understanding and the knowledge production process. The differences between traditional travel writing and digital narratives are evident with the traditional approach particularly favouring elements of depth of understanding and interpretation, the search for symbolic or implicit meanings and attempts to contextualise the unfamiliar. The paper argued that exposure to a foreign context alone does not produce intercultural understanding or meaning, giving rise to narratives that remain detached from their historical context, social complexity, and interpretive depth.

Ultimately, the paper concludes that the challenge facing intercultural education today is not the disappearance of intercultural encounter, but its transformation. In a context where cultures are increasingly encountered through screens, curated representations, and algorithmically structured visibility, intercultural competence may depend less on the quantity of cultural exposure available to students than on their capacity to critically interpret the representations through which cultural difference is made visible.

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Exploring Barriers to the Implementation of Inclusive Teaching Practices in Moroccan Context

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Abstract

Years after the implementation of the National Program for Inclusive Education in Morocco, many difficulties are still facing the education of students with disabilities in mainstream classrooms. This research aimed to explore cultural barriers to developing inclusive teaching practices to guarantee quality learning for all students. We conducted a series of focus groups with teachers in three inclusive schools, located in the West-East of Morocco, we adopted a content analysis, and we found out that teachers were (1) adopting cultural background to a disability, (2) and they were not able to develop inclusive teaching practices based on human right's approaches, (3) consequently, they were unprepared to teach students with severe or mental disabilities, (4) However, they have promoted social abilities in school. Our research may help to design a contextualized training program for future inclusive teachers.

Keywords: *Inclusive education, disability, Inclusive teachers, inclusive practices.*

1. Introduction

Despite all the efforts to fulfil all students' right to quality education in Morocco to achieve the 4th Sustainable Development Goal 2015/2030, there are still many difficulties, some are related to the social perception of disability and others to teachers' professional training, which affected the nature of teaching practices within inclusive classrooms and consequently impacted the quality of learning of students with disabilities in mainstream schools.
In this research, we investigated the barriers that hinder the implementation of teaching practices in inclusive classrooms in poor arias. We chose the South-East of Morocco, and we focused on Zagora territory, especially three schools situated in three different villages. These schools contained the highest number of students with disabilities in mainstream classrooms, in some classrooms; they represented the third of all students. Teachers within the three schools have adopted a philanthropic background to disability and promoted social abilities, among students, to accept differences and diversity. However, they have not been able to teach students with disabilities, which led us to explore their background in disability and the way it affected their teaching practices.

2. Literature Review

Inclusive education is recognized as a fundamental human right for everyone (Ainscow 2021), it provides all learners with an equitable learning environment' and quality educational outcomes. In this perspective, inclusive education requires more than placing children with disabilities in mainstream classrooms; rather, it focuses on the socio-emotional and academic development of every learner. The implementation of inclusive education necessitates a paradigm shift in educational practices, including developing the non-academic skills of all learners as well as exploring diverse perspectives related to school contexts, such as parents' voices and contributions (Schwab et al. 2020). In Morocco, children with disabilities have enrolled mainstream schools after the ratification of the Incheon convention in 2016. However, many challenges impeded the implementation of adequate inclusive teaching practices in schools, like the blurred conceptualization of the inclusion in school context, the limited or partial inclusion of learners with disabilities, the poor quality of the training provided to principals and teacher, as well as the technical and financial constraints, and the lack of stakeholders' involvement, including parents. However, parental involvement is a crucial factor contributing to developing any academic inclusive system.
Additionally, Good and Trusting relationships between the family and school staff emerge when they see each other as trustworthy partners and allies, and when the family have multiple opportunities for

purposeful engagement in its child's education (Hanssen N and Erina I 2022), which enhances learning, positive behaviour and decreases achievement gaps between students, including the ones with disabilities. Furthermore, Good parents and school staff partnerships lead to the improvement of teachers' efficacy, family satisfaction and parenting skills. However, many parents have expressed concerns about the quality of teachers' instruction, classrooms' inclusive management, peers' bullying behaviour, social isolation (Lalvani 2015), teachers' and school staff's negative attitudes towards disability. Moreover, mainly teachers and school staff focused on informing parents instead of building a profitable relationship, which created different perceptions of what constitutes meaningful parent involvement.

Indeed, the contribution of parents of learners with disabilities to evaluate the effectiveness of inclusive practices is important to ensure a successful evaluation and reform toward inclusive education, since parents are considered important actors and agents in the school context and should be involved in developing inclusive education.

We aim to bring to the fore parents' voices, exploring their view of the relationship between them and teachers on inclusive education for their children with disability Inclusive education is recognized as a fundamental human Right, it provides all learners with an equitable learning environment and quality educational outcomes. Furthermore, inclusive education requires more than placing children with disabilities in the mainstream classroom and focuses on the socio-emotional and academic development of every learner. The implementation of inclusive education necessitates a paradigm shift in educational practices, including developing the non-academic skills of all learners and exploring diverse perspectives related to school contexts, such as parents' voices and contributions. In Morocco, children with disabilities have enrolled mainstream schools after Moroccan ratified the Incheon convention in 2015 (UNESCO 2015a). However, many challenges have impeded the implementation of adequate inclusive teaching practices, like the poor quality of teacher training, technical and financial constraints, and the lack of parental involvement(CSEFRS 2019a), even though, it is a crucial factor contributing to developing any academic inclusive system (Connolly and Gersch 2016).

Good and Trusting relationships between the parents and school staff emerge when they see each other as trustworthy partners and allies and when the family maintain multiple opportunities for purposeful engagement in school life, which enhances learning and positive behaviour and decreases achievement gaps between students, including the ones with disabilities. Furthermore, Good parents and school staff partnerships lead to the improvement of teachers' efficacy, family satisfaction and parenting skills. However, many parents have expressed concerns about the quality of teachers' instructions, classroom management, peers' bullying behaviour, social isolation, and teachers' negative attitudes towards disability. Moreover, they have confirmed that teachers and school staff focus on informing instead of building a profitable relationship, which produced distinct perceptions of what constitutes meaningful parent involvement.

Indeed, the consent and contribution of parents of learners with disabilities to evaluate the effectiveness of inclusive practices are critical. Therefore, parents are considered important actors and agents in the school context and should be involved in developing inclusive education.

We aim to bring to the fore parents' voices, exploring their view of the relationship between them and teachers on inclusive education for their children with disability.

3. Research Problem

Inclusive teaching practices require the removal of discrimination on the grounds of disability felder, 2019, the promotion of a positive school climate (Cohen, J. & Brown 2013), the modernisation of teaching approaches (Hulgin and Drake 2011), to removal of barriers to all learners' participation (Dovigo 2017), the improvement of the quality of the interventions with students and families (Heyer 2021), and the exploration of every learner's needs within the society's context (Ainscow 2020; Al-Shammari, Faulkner, and Forlin 2019).

Analogously to the 4th article of the united nation's convention on the rights of persons with disabilities (U.N 2006), the Incheon Declaration and Framework for Action for the implementation of Sustainable Development Goal 4 (UNESCO 2015b), and the Moroccan Framework Law 51-17 (sgg.gov 2020), Morocco has engaged to include students with disabilities in mainstream schools (MEN and UNICEF 2019). However, without adjusting the infrastructure and teachers' training required for inclusion (CSEFRS 2019b), and without empowering teachers as agents of change (UNESCO 2020), able to visualize what can be achieved after removing barriers Ainscow 2020, 2021. This led us to question the barriers that hinder the development of the adequate teaching practices within inclusive classrooms.

4. **Research Methods**

To explore the impact of the implementation of an inclusive education program in Morocco, we focused on inclusive teaching practices by conducting a series of focus groups with 24 teachers from three different schools in the south-East (Draa Tafilalete Academy) with the permission of the local educational board. We chose the schools with the highest number of students with disabilities within mainstream classrooms. We met the participants in schools, during the break, and we questioned them about their cultural background and understanding of inclusion, their teaching practices to include all learners, and their reflections on the inclusion of all learners in their schools. All the participants (19 males and 6 females) have not been engaged in any voluntary or mandatory training about inclusive education or inclusive pedagogy. However, they were open to talking about their attitudes, knowledge, skills, and readiness to teach in inclusive classrooms. After conducting the focus groups, we adopted a content analysis to extract the different barriers (cultural, institutional and technical) that hinder the implementation of a genuine inclusive teaching practice in mainstream classrooms in this area.

5. Results

After analysing the content of the teachers' focus group statements, we concluded that all teachers welcomed the access of children with disabilities to the local schools for the following reasons:
Firstly, they believed that the access of children with disabilities to mainstream classrooms was the consequence of the paucity of special educators and special education classrooms in their region, and they also expected that the education board will assign special educators to teach, separately, students with disabilities. This attitude, conveyed by teachers, uncovered the real and the concealed motives to accept students with disabilities in their classrooms, in other words, teachers couldn't refuse or criticize the official instructions and they considered the situation transient. This showed that they have not been sensitized or familiarized enough with the principles of inclusive education; and consequently, they have not felt the professional or ethical obligation to challenge and develop their current teaching practices.
Secondly, teachers' discourse about disability was predominated by both philanthropic background medical approaches to disability. Thus, such attitude prevented teachers from approaching disability as a social construct jones 1996 and exploring the diverse personal potential of all students regardless of their impairment le (Le Fanu 2014). This conclusion aligns with what (Winzer 2007) said about disability and philanthropic perspective and which considered the charitable action to people with disabilities as an opportunity to give alms and to please God; such attitudes maintain the inferiority with few rights for people with disabilities (Winzer 2007).
Thirdly, all teachers, in the three schools, have been promoting social abilities for all students based on religion as a component of the school curriculum; the aim is to enable students to accept each other regardless of differences, and to avoid labelling according to physical, ethnic or social circumstances. However, despite teachers' efforts, they were facing the uncooperative attitudes of families and the floundering decisions of the education board towards the conceptualisation and the operationalisation of inclusive education.

6. Discussion

Teachers' intentions to include all learners within mainstream classrooms couldn't change the fact that teachers were struggling to manage inclusive classrooms, which increase the gap between the discourses about inclusive education and the existing inclusive teaching practices within classrooms. Furthermore, teachers of the three schools confirmed their unpreparedness to teach learners with disabilities, especially the ones with severe or mental disabilities. Besides, they were all the time under pressure to deliver the official curriculum at a restricted timetable, which forced them to focus on "abled students" and to marginalize the ones with disabilities by keeping them busy (drawing or coloring) or silent to avoid the disturbance or interruption of the courses. However, at the end of the school season, and to prevent the school failure of "disabled students", teachers would elevate them to the next level and so on. Which, often, led to a poor quality learning, limited the learning opportunities, and established low expectations (OHCHR 2016).
In our research, teachers confirmed that the adoption of philanthropy as a background to disability was the result of a cultural legacy and the lack of genuine training based on humanistic and right-based approaches. Additionally, they revealed that they have been trained to promote standards of excellence, by increasing competition between students based on ableism and similarity instead of exploring students' potential and differences. Indeed, the focus group's discussions were an opportunity for

teachers to reflect on the problem of learners' marginalisation in schools and on the need to challenge and change ableism-based standards in schools and societies. Moreover, the analysis of the results showed that teachers' failure to teach all students lowered their self-esteem, their preparedness to manage inclusive classrooms, and their ability to explore the strengths of all students, which aligned with other researches' findings about the attitudes toward disability, self-esteem (Byra and Domagała-Zyśk 2021) and workplace wellbeing (Agran et al. 2020).
Furthermore, teachers were facing different barriers related to the feasibility of inclusion in rural schools, the adequate support for all students, the degree and quality of knowledge and skills required to, effectively, manage inclusive classrooms (Botha and Kourkoutas 2015). Consequently, some teachers criticised these requirements because of the uncertainty about what they need to believe, know and do to be able to support inclusive and equitable education for all (Florian 2014, 2021). Therefore, new teaching approaches are needed to respond to the differences in inclusive classrooms and to narrow the gap between teachers' knowledge and practices within their classrooms (Florian 2021). In other words, teachers need different values, beliefs, knowledges, understandings, skills, and abilities to be effective with diverse groups of students (EADSNE 2012; Florian 2021). They also need a framework to bridge coursework and practicum experiences about inclusive education as a way to synergize both of them (Rusznyak and Walton 2019), which means that teachers and researchers need to work collaboratively to develop context-based inclusive practices, which will, constantly, vary according to the individuality of the learners and the school context (Florian and Pantić 2017).
Indeed, Teachers in Morocco need to be aware of the cultural, institutional, and technical barriers that prevent them from changing their attitudes toward differences in mainstream classrooms. Furthermore, they need to critically analyze the injustice in the schooling system's structure (Tomlinson 2017), develop the habits of the head, hand, and heart linked to the core values of inclusive pedagogy (Florian 2021), and include the use of technology to and new methods to respond to students' different needs (Hardman 2019) (Magyar et al. 2020), (Mohamed 2018).

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7. Conclusion

Morocco is engaged in including all learners in mainstream schools. However, some barriers are still hindering the achievement of this goal.
We have explored and examined those barriers from teachers' perspectives. We concluded that some of them are related to teachers' cultural background that forges their attitude to differences in general and to disability in particular, other barriers linked to the institutional conceptualization and operationalization of inclusive education in general and inclusive teaching practices in particular, and some barriers are related to the material and technical situation of schools. However, teachers have to manage inclusive classrooms without being prepared, which affected their practices and their expectations from all learners regardless of their ability.
Indeed, the access to mainstream classrooms is not enough to guarantee all students right to quality education in Morocco, there is a need for the implementation of a genuine contextualized training program that takes in consideration the newest theoretical and practical research, on one hand, and the convictions and engagement of teachers, researchers, families, the educational board, the stakeholders and the local community, in another hand.

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Supporting Learning in Contexts of Disruption by Natural Disaster, War, and Communal Violence: A Comparative Case Study of Scalable Strategies from Four Settings

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Abstract

Educational continuity amid civil strife, forced migration, or severe climate events is an urgent global concern. Increased frequency of such disrution calls for fresh and innovative approaches. This paper synthesizes evidence from mixed-methods field studies, program evaluations, and policy research analyses across diverse settings—including Hurricane Katrina (Louisiana, 2005), protracted communal violence in Northern Ireland, recent traumatic disruptions in Gaza, and a 2024 disaster-management e-learning initiative in Saudi Arabia led by ULS—to identify scalable strategies for supporting educators and learners experiencing disruption. We conceptualize disruption as a multidimensional process—physical displacement, infrastructure loss, psychosocial trauma, and institutional breakdown—and examine how these dimensions interact to undermine access, quality, and equity in education. We explore potential pathways of risk management and amelioration. Employing a comparative case-study design, data were drawn from rapid assessments, semi-structured interviews with educators and learners, classroom observations, and monitoring data from interventions implemented between 2018–2024, including outcomes from the ULS e-learning policy preparation for continuity management in Saudi Arabia. Findings show hybrid delivery models that combine low-tech solutions, community-based learning hubs, protected learning spaces, and context-tailored e-learning platforms achieve higher short-term retention and modest gains in foundational skills versus standard relief distributions. The ULS initiative demonstrated how disaster-management integration and rapid e-learning deployment can maintain instructional continuity for displaced and remote learners when paired with local support structures. Trauma-informed teacher training and flexible, modular curricula improved psychosocial wellbeing and classroom engagement.

Keywords: *Disruption; traume; disaster management; continuity; displacement; risk assessment*

1. Introduction

Educational continuity during civil strife, forced migration, or severe climate events has become an urgent global concern. Over the past decade, the frequency and intensity of such disruptions have risen sharply. According to the United Nations Educational, Scientific and Cultural Organization (UNESCO, 2023), more than 224 million school-aged children are now affected by crises annually, many experiencing prolonged interruptions to their formal education. Traditional humanitarian responses have rightly prioritized physical safety, food, and shelter, but educational continuity has often been treated as a secondary or long-term recovery goal. This delay creates lasting harm: lost learning compounds over time, psychosocial trauma remains unaddressed, and displaced learners may never return to formal schooling (Burde et al., 2017; Winthrop & Anderson, 2019).

Existing research tends to examine individual disruptions in isolation—hurricanes, wars, or pandemics as separate categories. Few studies compare how different types of disruption shape educational outcomes and responses. Furthermore, scalable strategies that bridge emergency relief and long-term system resilience remain underdeveloped. In particular, the interplay among physical displacement, infrastructure loss, psychosocial trauma, and institutional breakdown is rarely analyzed as a multidimensional process. We conceptualize disruption as a multidimensional process and examine how these dimensions interact to undermine access, quality, and equity in education. We explore potential pathways of risk management and amelioration.

This paper addresses three specific gaps in the literature. First, it offers a cross-contextual comparison of educational disruption mechanisms across natural disaster, war, and communal violence. Second, it integrates quantitative retention data with qualitative teacher and learner perspectives in a single mixed-

method design. Third, it proposes a pragmatic, actionable framework linking scalable delivery models to governance and equity. To achieve this, we synthesize evidence from four distinct settings:
Findings show hybrid delivery models that combine low-tech solutions, community-based learning hubs, protected learning spaces, and context-tailored e-learning platforms achieve higher short-term retention and modest gains in foundational skills versus standard relief distributions. The ULS initiative demonstrated how disaster-management integration and rapid e-learning deployment can maintain instructional continuity for displaced and remote learners when paired with local support structures. Trauma-informed teacher training and flexible, modular curricula improved psychosocial wellbeing and classroom engagement. Local governance and community-led resource mobilization consistently predicted program sustainability. The role of EU sypport in Northern Ireland is referenced with regard to sectarian divisions and mutual hostility. Persistent barriers include fragmented funding, weak outcome measurement systems, and limited pathways for credentialing disrupted learners.
We propose a pragmatic framework for policy and practice integrating: (1) context-sensitive modality selection, (2) adaptive assessment and credentialing, and (3) investments in policy capacity and governance. Recommendations emphasize flexible funding, interoperable data systems, mediation supports, post-trauma counselling and pre-positioned contingency curricula. Centering equity and local agency, the framework aims to strengthen education system resilience and ensure learning continuity amid severe disruption.
The context of this orientation is to address the challenges posed by emergencies that may disrupt traditional modes of education delivery. Natural disasters, pandemics, and other crises can make it challenging to continue education using traditional methods. Therefore, there is a pressing need for many governments to have national plans in place that enable a rapid and effective transition to digital learning to ensure uninterrupted education in such situations. This aims to provide a strategy for educational institutions and stakeholders to overcome the challenges of emergencies and ensure continuity of learning for learners. The central research questions are:

1. How do physical displacement, infrastructure loss, psychosocial trauma, and institutional breakdown interact to undermine educational access, quality, and equity?
2. Which hybrid delivery models achieve higher short-term retention and foundational skill gains during disruption?
3. What barriers and enablers shape program sustainability across different disruption types?

2. Conceptual Framework

The analysis is based on the reports and findings of UNESCO, OECD, OLC, World Bank, NELC and other relevant sources which, in recent times, have specifically discussed the impact of the Covid-19 pandemic on education and the various national responses that have been implemented to try to ensure continuity of education under crisis situations. Preparedness in providing distance learning opportunities under emergency conditions is also included in the focus.
This growing impact and integration of new technologies has created a new paradigm in educational systems. Traditional educational models have also incorporated various advanced technologies and digital tools in their systems. In the same way, fully digital online systems have incorporated direct workshops and community learning approaches.
Globalization has given a special flavor to these developments. In many ways, it is a short journey from collaborative partnerships to a set of special interests and capacities which need to be protected in an atmosphere where there is increasing competition for scarce resources. Educational Institutions find themselves subject to huge competitive pressures in everything from comparative league tables to outsourcing, institutional amalgamation and rationalization. The spread of the knowledge economy (itself accelerated by vastly improved and sophisticated communications technologies) has been paralleled by significantly increased student and faculty mobility.
Underlying this vast and often unsettling process, as we have seen, is an increasing level of integration between learning systems or educational institutions and the world of industry and enterprise. At a societal level, education therefore plays an important balancing role between stability and change. It both integrates the current and future members of society in a collective system and enables social change and development in this collective system. This inner contradiction generates a tension that produces different forms of educational systems in each era and in each social context. Throughout all these processes, we are left with the critical importance of both *communication* and *community*. This has assumed huge importance as we look at the role of education systems and the generation of innovation and responses to the pressing social needs of a globalized era. It also assumes huge

importance when we look at the potential impact of disruption, emergency and or social crisis on provision of educational resources and student support in times of crisis.
Disruption interferes directly with this balance of tensions. The assumed stability of the education sector is as vulnerable to disruption and destruction as any other. Therefore, the specific conditions and characteristics of the process and the responses to it assume great importance in both planning for and responding to disruption. These issues are examined from various perspectives including, for example, pedagogy, educational technology, resources, capacities.
Based on current data available, the planning of continuity of education at the national level is characterized by the experience of the Covid-19 pandemic. Apart from anything else, this means that many of the planned actions are aimed at recovery rather than long-term sustainability. This "reactive" and rather short-sighted approach to continuity planning typically focuses on immediate actions and "what is possible under given circumstances". Findings from various national contexts, however, report critical gaps or weaknesses in how teachers and principals are supported in distance education modalities.
There are also critical gaps and weaknesses in how pedagogical approaches have been adapted to the needs of the specific sector of distance education. The fourth UNESCO report focusing on education transformation from the basis of Covid-19 experiences makes a critical point on this issue by stating:
The evidence is overwhelming that structured pedagogy programs – including supporting teachers with teachers' guides, structured lesson plans, student materials and teacher training – leads to improved learning outcomes. (UNESCO Institute for Statistics et al., 2022)
Many of the given issues impact teacher well-being which may have long-lasting consequences. The transformation process to distance education has to take place with adequate planning and strategic thinking, as well as sufficient support and resourcing (Vuorio et al 2021).
It is possible to conceptualize disruption as a complex multidimensiona process. In this analysis we see disruption comprising four interacting dimensions.

1. Physical displacement: this refers to the forced relocation of learners and educators away from their normal school communities.
2. Infrastructure loss includes the destruction of school buildings, electricity, internet connectivity, and learning materials.
3. Psychosocial trauma encompasses fear, grief, hypervigilance, and loss of routine experienced by both children and adults.
4. Institutional breakdown involves the collapse or severe weakening of governance systems, including assessment, credentialing, teacher payroll, and ministry oversight.

These dimensions do not operate in isolation. In practice, they interact, influence and amplify one another. For example, trauma reduces attendance and concentration, which in turn weakens institutional oversight when schools do eventually reopen. Infrastructure loss makes displacement more prolonged and the actual impact more concrete and seemingly long-lasting. As a result, this in turn increases trauma. The followuing table illustrates how each dimension is manifested across our four settings.

Table 1. Manifestation of Disruption Dimensions Across Five Settings

Disruption /Case	**Hurricane Katrina (2005)**	**Northern Ireland (1970s–1990s)**	**Gaza (2023–26)**	**Saudi Arabia (ULS, 2024)**
Physical displacement	Widespread (evacuation to 48 states)	Moderate (internal, localized)	Severe (repeated displacements)	Moderate (remote learners)
Infrastructure loss	Severe (schools flooded/destroyed)	Mild (schools standing but segregated)	Severe (bombardment of schools)	Mild (connectivity gaps)
Psychosocial trauma	High (loss, family separation)	Severe (sectarian fear, hostility)	Severe (direct violence exposure)	Low (disaster preparedness context)
Institutional breakdown	Severe (district closure)	Moderate (parallel systems)	Severe (ministry functions collapse)	None (preparedness initiative)

We trace two types of pathways in our analysis: risk management pathways (mitigation, preparedness, response, recovery) and amelioration strategies (psychosocial support, flexible curricula, community learning hubs). This framework guides the methods and interpretation that follow.

3. Methodology

We employed a comparative case-study design (Yin, 2018), treating each disruption setting as a bounded case. This design allows systematic comparison across heterogeneous contexts while retaining contextual depth. It is particularly suited to studying complex, real-world interventions where randomization is impossible or unethical.
Employing a comparative case-study design, data were drawn from rapid assessments, semi-structured interviews with educators and learners (n=82), classroom observations, and monitoring data from interventions implemented between 2018–2024, including outcomes from the ULS e-learning policy preparation for continuity management in Saudi Arabia. Quantitative measures include enrollment, attendance retention, and foundational learning maintenace outcomes; qualitative analysis explores community adaptation, teacher decision-making, shared learning in contested socio-political societies experiencing violence and informal learning pathways.
In the following sections, we focus on selected national approaches which were designed to aim at continuity of education in challenging and disruptive circumstances caused by emergency conditions. The purpose is to provide an overview of different approaches and ways to support continuity of education and student support on a national level as well as to analyse in a more detailed way why certain strategies were implemented and what they aim at. There were several UNESCO national reports produced focusing on education responses to Covid-19 from Finland, the Republic of Korea (South Korea) and China which have been useful as main sources of information and associated themes. South Korea and Finland are both well-recognized countries in education with high PISA rankings over the past times. China represents a different, highly centralized and very scalable approach to education with a particularly high ranking in mathematics and science subjects. Findings which are found relevant for the scope of this paper have been included as examples and recommendations for further investigation as we consider the four primary examples.
The settings and specific cases under review and researched are summarised in Table 2.

Table 2. Settings and Cases

New Orleans, Louisiana	Natural disaster (hurricane, flooding, displacement)	2005–2008	Displaced students, relocated teachers
Northern Ireland	Protracted communal violence (sectarian)	Retrospective: 1972–1998	Cross-community education initiatives
Gaza, Palestine	War and traumatic disruption (active conflict)	2023–2026	School-based and shelter-based learning
Saudi Arabia	Disaster management e-learning preparedness	2024	E-learning policy, displaced/remote learners

The Saudi Arabian case was unique in that it involved a planned disaster-management integration strategy and plan led by ULS, rather than an acute emergency response. This strategy was to examine the state of emergency response and planning in eLearning in the Kingdom of Saudi-Arabia in order to propose a model for a national Emergency Remote Learning Plan focusing on K-12 education, Technical and Vocational Training and Higher Education. A framework was proposed and developed with recommendations and concrete actions to prepare for emergencies in advance, to manage them as they occur and for rapid recovery from such disruptions.
Data were drawn from five sources:

- Rapid assessment reports from humanitarian and government agencies (n = 12 organizational documents).
- Semi-structured interviews with educators and learners (n = 82 total; Katrina n = 24; Northern Ireland n = 18; Gaza n = 22; Saudi Arabia n = 18).
- Classroom observations (n = 34 sessions across active and post-disruption phases).

- Monitoring data from interventions implemented between 2018 and 2024, including ULS e-learning program logs.
- Policy and program evaluation documents from the European Union (Northern Ireland) and especially the EU Peace II program, and the Saudi Arabian Ministry of Education.

Quantitative measures included: enrollment rates (pre- and post-disruption), attendance retention at 4 and 12 weeks, and foundational learning maintenance measured by brief literacy and numeracy screenings (adapted from the ASER tool; Pratham, 2020).
Qualitative measures explored: community adaptation strategies, teacher decision-making under stress, shared learning in contested socio-political societies, and informal learning pathways such as home-based and peer tutoring.
Quantitative data were analyzed using descriptive statistics and, where pre- and post-disruption data were available, paired t-tests. Qualitative data were transcribed and analyzed using thematic analysis (Braun & Clarke, 2006), with initial coding followed by theme development and cross-case synthesis. Triangulation occurred across data sources and researchers.
Ethical approvals were obtained from the institutional review boards of the author's home institution and, where applicable, local research ethics committees in each setting. Informed consent was obtained from all interviewees. Pseudonyms are used for any direct quotes. In the Gaza case, additional safeguards were implemented to avoid identifying participants under active conflict conditions.

4. Issues Arising

The findings and results are organised into four subsections:

1. Quantitative results comparing hybrid versus standard models
2. Qualitative themes from interviews
3. Cross-case patterns
4. Persistent barriers.

Quantitative Results: Across all four settings, hybrid delivery models - defined as combinations of low-tech solutions (radio, printed packets), community-based learning hubs, protected learning spaces, and context-tailored e-learning platforms - consistently outperformed standard relief distributions (which typically provided only food, shelter, and basic supplies, with no structured educational component).
In the ULS Saudi Arabia case alone the initiative maintained instructional continuity for 89% of displaced or remote learners when paired with local support structures (teacher mentors and community Wi-Fi hotspots). E-learning platform usage peaked at 7,200 daily active users during the second month of disruption, with average session duration of 23 minutes.
Qualitative Themes: Four major themes emerged from interviews and observations.
Theme 1: *Community adaptation as the primary resilience mechanism.* In all settings, communities that self-organized learning spaces - mosques, community centers, tents - before external aid arrived had significantly better outcomes. A teacher in Gaza explained:

> *We did not wait for the ministry. Parents took turns teaching in shelters. The youngest learned letters; the older ones did math on rubble walls. It was not perfect, but it kept them from staring at destruction all day.* (Interview, Gaza, 2023)

Theme 2: *Teacher decision-making under stress shifts from coverage to care.* Teachers consistently reported rationing their emotional energy and prioritizing psycho-social safety over curriculum coverage. A Katrina respondent recalled:

> *I stopped caring about fractions. I cared about who was crying and who had not eaten. The curriculum became secondary to survival.* (Interview, Houston relocation center, 2006)

Theme 3: *Shared problem-solving reduces hostility in contested societies.* In Northern Ireland, EU-supported cross-community education programs reduced mutual hostility not through mere contact but through structured, sustained, shared problem-solving (e.g., joint community mapping and restoration projects). Respondents described this as building procedural trust before emotional reconciliation.
Theme 4: *Informal learning pathways are safety nets that widen equity gaps.* When formal schools closed, peer tutoring, family-led instruction, and self-directed digital learning filled gaps. However, equity worsened: learners with educated parents or stable internet access fared much better. A Saudi program coordinator noted: '*We saw children of university graduates thrive on the e-learning platform. Children of hourly workers without Wi-Fi at home—they disappeared from our data.'* (Interview, Riyadh, 2024
Cross-Case Patterns

Table 3. Enablers and Barriers Across Five Settings

Factor	***Katrina (2005)***	***Northern Ireland***	***Gaza***	***Saudi Arabia (ULS)***
Trauma-informed teacher training	Present but weak	Strong (EU-supported)	Emergent, improvised	Strong, pre-planned
Flexible/modular curricula	Limited	Strong	Strong (improvised)	Strong
Local governance & community-led mobilization	Mixed	Strong	Weak (external constraints)	Strong
Fragmented short-term funding	Yes	Yes	Severe	No
Weak outcome measurement systems	Yes	No (strong local research)	Yes	Partial
Limited credentialing pathways for disrupted learners	Yes	Historical yes	Minimal	No (planned)

Persistent Barriers Across Settings: Despite localized successes, three barriers appeared consistently across all settings:

1. **Fragmented funding** – Short-term humanitarian grants (typically 6–12 months) prevented multi-year planning, teacher retention, and sustainable partnerships.
2. **Weak outcome measurement systems** – Few settings had real-time data on learning (viz. attendance). Most relied on proxy indicators like food distribution counts or shelter enrollment.
3. **Limited pathways for credentialing disrupted learners** – Lost transcripts, unrecognized informal learning, and bureaucratic inertia blocked grade progression, certification, and transition to higher education.

5. Themes

The findings confirm that hybrid delivery models outperform single-modality relief. This aligns with recent guidance from the Inter-Agency Network for Education in Emergencies (INEE, 2024), but adds evidence from both natural disaster and active war settings. Notably, the advantage of hybrid models persisted even when internet connectivity was low, provided that low-tech components (printed materials, community hubs) were well designed.

Trauma-informed teacher training and flexible, modular curricula improved both psychosocial wellbeing and classroom engagement. This suggests that pedagogical adaptations are not separate from mental health support—they are intertwined. A teacher trained to recognize trauma responses and adjust lesson pacing effectively delivers psychosocial first aid while teaching literacy (Bragin et al., 2022).

Local governance and community-led resource mobilization consistently predicted program sustainability. External actors who bypassed local structures—for example, directly rebuilding a school without consulting community education committees—saw higher dropout rates when they departed. This finding echoes the broader development literature on local ownership (Andrews et al., 2017).

Relevant issues in the scope of this work, include an analysis of national responses and emergency learning planning actions. This study, like most other global reports and sources identified, focuses on K-12 education. This is logical because the global K-12 population of learners is considered among the most vulnerable when disruptions to education occur. Younger pupils are generally less capable of taking responsibility for their own learning than students in higher levels of education meaning that more teacher support is needed. Although many K-12-specific strategic approaches and proposed actions are relevant and transferable to the context of higher education, it is important to understand the differences between them. This is clearly seen, for example, in issues around learner autonomy and student support needs and requirements. This may require substantially different approaches when distance education is considered. OECD´s *"Policy Responses to Coronavirus"* report provides a practical insight to this:

While tertiary education institutions are largely used to delivering online courses and have a rich bank of online materials, this is less systematically true in primary and secondary education.

The *Economic Commission for Latin America and the Caribbean* (ECLAC) examined strategies for continuing education through distance learning modalities in 2020 in its report *"Education in the time of COVID-19"* (August 2020). This study provides insights from its specific cultural/geographical context which may help understand some differences and requirements that should be considered when aligning the plan to the needs of a national education system. This is particularly relevant given the geographic dispersion of many countries in this region (especially isolated islands in the Caribbean) and the high prevalence of natural disasters such as hurricanes.

The European Union's support for cross-community education in Northern Ireland is widely credited as a factor in reducing sectarian hostility (Smith, 2010; Hughes & Campbell, 2017). Our analysis suggests that EU funding was effective not merely because of financial resources, but because it was designed with specific conditions: long-term commitment (more than 10 years), mandatory cross-community collaboration for grant eligibility, and pairing of funding with mediation and dialogue training. Short-term aid without these conditions—as seen in the early Katrina response—failed to reduce tension and sometimes exacerbated competition for scarce resources.

Conclusions

This study has several limitations. First, four case studies cannot represent all disruption types; slow-onset climate displacement or pandemic-related school closures may operate differently. Second, retrospective data from Northern Ireland may suffer from recall bias, as interviews occurred decades after the events described. Third, the Gaza sample was constrained by active conflict; some interviews were incomplete, and follow-up was impossible. Fourth, we had no control group; causal claims are therefore cautious, and we present associations rather than definitive causation.

A pragmatic framework for supporting learning in disruption can be based on:

1. Content sensitive modality selection – matching delivery (radio printed packets, hubs, e-learning) to connectivity, security, cultural norms and available infrastructure
2. Adaptive assessment and credentialing - Micro-credentials, portfolio-based assessment, portable digital learner records (offline-capable)
3. Investments in policy capacity and governance - Pre-position contingency curricula, train local education cluster coordinators, embed education in disaster risk reduction plans

Specific recommendations from this framework:

Flexible funding: Shift from 6–12 months humanitarian grants to multi-year, unearmarked education-in-emergencies funding.

Interoperable data systems: Deploy lightweight, offline-capable learner tracking systems (open-source platforms such as OpenEMIS or Tangerine).

Mediation supports: Train teachers in conflict-sensitive communication and basic mediation for communal violence settings.

Post-trauma counselling: Integrate into teacher professional development, not only as pull-out services for learners.

Pre-positioned contingency curricula: Develop modular, grade-agnostic skills packs covering literacy, numeracy, and social-emotional learning that can be deployed within 72 hours.

Longitudinal tracking of credentialing pathways for disrupted learners over five to ten years.

Cost-effectiveness comparisons of hybrid versus standard relief models across different disruption types.

Controlled studies of AI-assisted offline learning tools in active conflict zones where connectivity is intermittent or absent.

Educational continuity amid severe disruption is achievable, but not through technical fixes alone. It requires governance, trauma awareness, community leadership, and flexible systems that treat learning as a lifeline, not a luxury. The evidence from these five settings suggests that waiting for stability before investing in education is exactly the wrong strategy—by then, too many learners have already been left behind.

While it would appear that a good majority of countries have implemented some kind of continuity plan, when concrete actions are concerned, technology seems to be the primary driver. Courses are made available using existing channels and services such as TV and video streaming services. These studies reveal significant gaps in terms of learning **content** (both exclusive and OER) and teacher support. Both these elements stand out from more in-depth examinations of national emergency learning strategies. A central observation therefore is that the point of this analysis is not simply to have a plan. It is even

more important to have a strategic sense of *priorities* and *actions* that enable the aspirations of a plan to be implemented in practice.

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Listening to Children's Voices in War: A Study on Emotions, Coping, and Needed Support

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Abstract

This paper addresses the consequences of the psychological traumas experienced by a focus group of children from Gaza, aged 5-9 years old, from their own perspectives, during the current war in Palestine, who have been identified through a previous study as experiencing post-traumatic stress syndrome. ***Section 1*** *establishes the context for the study, the theoretical background, previous studies, and sets out methodologies used in the research; the difficulties and complexities of gathering the information are identified, with an example of interview methods and ethical considerations for children are illustrated. In* ***Section 2,*** *the consequences of the effects of trauma from living in an ongoing conflict situation are examined; comparisons are made with other types of distressing situations such as natural disasters; the factors that impact on recovery and resilience are explored with implications for recommendations such as focusing on supporting close family attachments.* ***Section 3*** *recounts the narratives of the children interviewed, structured into various categories of responses and effects, such narratives revealing profound psychological, emotional, and developmental impacts; the emergent themes are identified, with the children's accounts reflecting a deep disruption of safety, attachment, and normal childhood functioning.* ***Section 4*** *includes detailed analysis of the* findings*, which demonstrate that children's psychological distress cannot be separated from the structural and material conditions, the ongoing nature of the bad conditions prevent a return to normal functioning for the children. These recommendations should determine steps to be taken to alleviate suffering and long-term damage, by providing comprehensive support and treatment for the children, in particular supporting effective family functioning. Finally, recommendations and suggestions are proposed for short-, medium- and long-term interventions and supports.*

Keywords: *Trauma, Recovery, Resilience, Children, Conflict*

1. Introduction

Children are among the most vulnerable populations in times of war. Their direct voices are, however, rarely centred in research or humanitarian programme design [6, 21]. Most studies focus on diagnosed pathology and rely on adult intermediaries – parents, teachers, or aid workers – to interpret children's experiences, effectively denying children agency in issues that directly affect them.

This study addresses that gap. It builds on an earlier research study [2] conducted with 387 parents and carers of children aged 5–9 in the Gaza Strip, which identified PTSD in 87% of the children studied. In this second study, the children themselves speak.

Twenty-four children, selected from families who had participated in the earlier study, were interviewed in October 2024 whilst the conflict continued. A phenomenological/narrative inquiry methodology was employed. The Lundy Model [12] provided the ethical and methodological framework, ensuring children were given Space to express their views; Voice in a supported setting; Audience through systematic analysis; and Influence through recommendations directed to relevant actors. Three core areas were addressed: the emotional and physical impact of the war; coping mechanisms employed by the children; and identified support needs. Twenty of the twenty-four children were accompanied by both parents at the time of interview. This cohort of children does not appear to have suffered major physical injuries such as limb loss; recommendations nonetheless address support for injured children, given that Gazan children have the world's highest rate of limb amputations.

2. Children and Trauma

2.1 Listening to Children's Voices

Involving children in decisions and research that affects them is their right [20]. The Lundy Model [12], rooted in Article 12 of the UN Convention on the Rights of the Child, provides a practical framework for gathering children's perspectives authentically and ensuring those perspectives carry influence. The four elements – Space, Voice, Audience, and Influence – are of equal weight; without Influence, the process risks becoming tokenistic.



Fig. 1. Lundy Model of Child Participation

2.2 Children in War and Natural Disasters

Children in conflict zones face profound psychological harm, including PTSD, depression, and anxiety disorders [1, 19]. Research comparing war-affected children with those exposed to natural disasters is instructive. Studies of children following earthquakes and tsunamis show that, with appropriate post-disaster supports, many children demonstrate recovery or significant symptom reduction [10, 17, 22]. In the context of a protracted, ongoing conflict, however, conditions are fundamentally different: there is no stable recovery period, no reliable reconstruction, and no end point to the suffering [7]. Research on Gaza prior to the current conflict already documented significant associations between ongoing war trauma and PTSD, depression, and intergenerational harm [19]. Gaza's children face uniquely sustained exposure, placing them at elevated and persistent risk.

2.3 Recovery and Protective Factors

Several factors influence recovery from trauma: secure attachment [5, 11, 15, 16]; caregiver emotional regulation [5, 11]; social support [3, 13]; and structured psychosocial or therapeutic interventions [4, 8]. Research by Perry [14] demonstrates the beneficial impact of relational health and strong attachment in the early years on children's capacity for recovery from adversity. The HOPE model [18] – Health Outcomes from Positive Experiences – proposes four building blocks for mitigating trauma: safe and supportive Relationships; stable Environments; social and civic Engagement; and Emotional Growth. These building blocks, alongside evidence-based interventions such as Narrative Exposure Therapy [8], inform the recommendations in Section 4.

3. Children's Voices: Analysis of Interviews

3.1 Overview

The children's responses reveal profound psychological, emotional, and developmental impacts associated with prolonged displacement, exposure to violence, loss of basic needs, and the absence of any visible recovery. Qualitative analysis identifies seven inter-related themes arising consistently across the responses. Representative quotes, translated from Arabic, are included throughout.

3.2 Anticipatory Grief and Existential Terror

The children's accounts describe not imagined fears but realistic threat assessments based on lived experience. Recurring dreams of bombing, of planes "wanting to kill us," of being buried under rubble, and of relatives dying under destruction reflect daily reality. One child described the drones as "on the back of our heads all the time." Crucially, these responses indicate not only PTSD but ongoing traumatic stress – the threat has not passed. The children are not recovering from a traumatic event; they remain inside it.

3.3 Ambiguous Loss and Complicated Grief

Many losses remain unverified. Relatives described as "under the rubble" leave young children uncertain whether those people are dead, particularly when children have also witnessed people being recovered alive. This ambiguity disrupts the normal grief process: without ritual or closure, mourning becomes suspended, increasing the risk of long-term psychological damage. One child described: "I always see my Uncle when he was taken out from under the destruction, his hair was white and every face was blood and dirty clothes."

3.4 Cognitive Disruption and Educational Impediments

The children speak repeatedly of lost concentration: "I can't focus on anything, I think all the time about my father and mother and sisters." This is neurologically predictable. When the brain's threat-detection systems remain chronically activated, the prefrontal cortex – responsible for executive function, concentration, and learning – is effectively offline [9]. This is not a choice; it is automatic physiology occurring during critical developmental periods. Without intervention, the long-term effects on educational and cognitive development are substantial.

3.5 The Obliteration of Safety and Stability

The most consistent theme across all testimonies is the simultaneous destruction of every element of a child's world. "I am alone without my sisters and without mum and dad and also without a house and without games and without my school – all these things make me very angry." Home, toys, school, friends, relatives, and routine have been lost not sequentially but all at once, and without any clear prospect of return.

3.6 The Inversion of Childhood Roles

The children describe standing for hours in queues for water, bread, and food – roles normally belonging to adults. They are required to perform adult survival tasks whilst being held to the emotional standards of childhood. The resulting dysregulation is evident throughout: multiple children describe wanting to "break everything," fighting with siblings over "the simplest things." "When I am mad I start screaming and hitting and I want to break everything in front of me. We are humiliated in queues and this makes me mad all the time." This reflects a nervous system in survival mode, not moral failure.

3.7 Betrayed Expectations and Shattered Trust

A foundational element of early child development is the establishment of basic trust – the understanding that the world is predictable and caregivers reliable. "They told us that I will stay in the tent for a couple of days and then I will go back home, so I did not bring our toys or nice clothes or books with us, but I have 7 months in the ugly tent." When this trust is systematically violated, children face a cognitive dissonance that is difficult to resolve: they cannot fully trust the adults they depend upon for survival, yet have no alternative. Dreams of being "in a dark place and no one is helping me" and of "screaming and no one hears me" reflect this specific experience of abandonment.

3.8 Fragile Resilience and Conditional Coping

Many children cannot articulate resilience because they do not feel resilient. "I don't want to live in this situation, it is very hard for us without food or clothes or friends or grandfather and grandmother." Those who describe coping refer to parental encouragement, sibling cooperation, or prayer – survival strategies

rather than recovery. A meaningful distinction exists between resilience – returning to baseline functioning – and adaptation under duress: finding ways to survive that compromise long-term wellbeing for short-term survival. These children are in the latter category.

4. Findings and Recommendations: A Framework for Support

4.1 Findings and Implications

The findings demonstrate that children's psychological distress cannot be separated from structural and material conditions. The ongoing nature of the conflict prevents any return to normal functioning, whilst chronic shortages of food, water, shelter, and stability exacerbate emotional suffering and undermine any fragile coping. If unaddressed, the documented emotional, cognitive, and behavioural impacts carry lasting consequences: impaired emotional regulation, disrupted attachment, poor educational outcomes, and a significant risk of intergenerational trauma transmission.

4.2 Recommendations

Child Protection and Safe Environments: Creation and maintenance of child-friendly spaces providing physical safety, routine, and emotional containment; strengthening of family unity and reunification; dedicated supports for unaccompanied minors; training for communities, educators, and professionals to identify and respond to protection risks including emotional abuse, neglect, and peer violence; and safe reporting and monitoring mechanisms.
Mental Health and Psychosocial Support (MHPSS): Scaling up of child-focused MHPSS services; implementation of Psychological First Aid (PFA) using age-appropriate, culturally relevant methods including play, music, art, and storytelling; establishment of referral pathways for children requiring specialist care; integration of grief and loss interventions; and regular sleep and stress-regulation activities to address nightmares and sleep disturbance.
Cognitive and Educational Recovery: Re-establishing structured learning routines in formal or informal settings as early as possible; integrating social-emotional learning and psychosocial activities within educational programmes; adopting flexible, trauma-informed teaching approaches that accommodate reduced concentration and memory difficulties; and supporting religious and cultural learning activities – such as Qur'an memorisation – in low-pressure ways that restore a sense of competence.
Family and Community Interventions: Parenting support programmes equipping caregivers with trauma-informed skills; practical tools for emotional regulation and positive communication; encouragement of family-based coping strategies including shared routines and play; inclusion of caregivers within MHPSS programming to address their own distress; and community-led activities that promote collective coping and mutual assistance.
Basic Needs, Coordination, and Policy: Improving access to food, water, shelter, and clothing, recognising their direct impact on psychological wellbeing; reducing the burden of long and undignified queues through better aid distribution; minimising repeated displacement with honest family communication; and integrating MHPSS and child protection as core components of humanitarian response planning, with sustained funding for long-term psychosocial recovery beyond immediate emergency relief.

Conclusion

This study, conducted through direct engagement with twenty-four children in the Gaza Strip during the ongoing conflict, demonstrates that children's experience goes far beyond what traditional assessments or adult narratives capture. The war has produced profound disruption to their psychological, social, and cognitive lives – disruption that is structurally linked to harsh living conditions, repeated displacement, and the complete absence of any stable recovery.
The application of the Lundy Model provided a methodological framework enabling children to express their views clearly within a safe space, ensuring their voices reach an audience with the capacity to influence policy and practice. This approach addresses a significant gap in the literature: children's direct voices in conflict-affected environments are rarely heard.
The findings underscore the need for multi-level psychosocial interventions responding to immediate needs whilst building towards long-term recovery, and for strengthening the role of family, school, and community as foundations of resilience. They also highlight the urgent need for policies that protect

children, provide stable environments, and work to reduce the intergenerational transmission of trauma. This study offers a knowledge base for designing intervention programmes, promoting informed policies, and directing future research towards approaches that genuinely centre children's perspectives in decision-making.

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The Challenges of Educational Change in a Learning Organization in Slovakia

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Abstract

While changes in education are often analyzed through abstract sociological frameworks, this study bridges the gap between theory and practice by examining the internal organizational transformation of a selected Slovak elementary school. Based on concepts of transformational leadership and school culture, the study goes beyond the framework of top-down policy implementation and analyses how a school's internal mechanisms can actively combat institutional inertia.
Using a qualitative case study approach, we examine practical interventions implemented by the school administration and teaching staff to bridge the gap with the local marginalized community. These measures included direct personal visits by teachers to the excluded community, local awards for student attendance, and school community service projects aimed at engaging parents. Initial results indicate a significant empirical impact: over a two-year period, school attendance among children from the marginalized community increased by more than 20%. Furthermore, these interventions have successfully stimulated parental involvement and fostered unprecedented sociocultural ties between families from the marginalized community and families from the majority population. At the same time, a unique phenomenon has emerged —based on the initiative of the school's management and governing body, a proposal for the division of new school districts was introduced and implemented by the Ministry of Education of the Slovak Republic as part of the new school reform starting from September 2026, placing the school examined in this research in an unquestionably unique situation within the Slovak educational landscape.
The study thus also has a political-urban dimension in the context of the new municipal school policy. Ultimately, this study demonstrates that the sustainable transformation of education depends not only on well-thought-out internal changes within the educational institution, but also on local cultural reorganization and proactive, community-driven synergy.

Keywords: *educational change, school culture, education policy transfer, school leadership*

1. Introduction

In contemporary pedagogical and sociological theory, the concept of educational change represents a multifaceted phenomenon that cannot be reduced to the mere implementation of new curricular goals or organizational adjustments. Educational change is, at its core, an ontological process that affects the deep structures of institutions and the professional identity of their actors. As Fullan (2007) notes, the essence of change lies in the process of seeking and attributing new meaning to educational activity. However, this process is inevitably confronted with institutional inertia and social mechanisms, which Bourdieu (1990) defines through the concept of "habitus." In the school environment, habitus functions as a set of deeply rooted dispositions that predetermine the behaviour of actors and often act as an unconscious but powerful filter against any external innovative efforts.
Conceptualizing educational change requires an understanding of the historical and professional context of teaching (March, 1994). In his classic analysis, Lortie (1975) points out that educators are shaped by long-term socialization within the traditional school system, which creates a conservative framework resistant to change. This professional isolation is reinforced by the specific organizational structure of the school, which Mintzberg (1979, 1989) characterizes as a professional school bureaucracy. In such an environment, power is dispersed among autonomous professionals, leading to a phenomenon that Weick (1976) defined as "loose coupling." A critical understanding of educational change must therefore consider the micropolitical reality of schools. Blase (1991) and Ball (2015) emphasize that the school is not a monolithic unit, but an arena of constant struggles for influence, resources, and recognition. In this sense, educational change is not merely an administrative act but the result of complex negotiation and strategic action. If change does not reflect these power relations, it falls into a cyclical repetition that Cuban (1990) critically describes as "reforming over and over again" (p.1). The successful

implementation of educational changes and the subsequent transformation of the school therefore requires not only a change in structures within the educational institution, but above all the building of the school's capacity as a learning community (Stoll, 1999), where school leadership does not act in a directive manner, but as a catalyst for collective development (Leithwood and Jantzi, 1999; Ullah and Muslim, 2025).

1.1 Traditional and Contemporary Paradigms of Educational Change

The traditional paradigm of educational change, based on the work of Lewin (1947), was grounded in a linear model of social equilibrium. This approach assumed that the educational system is a stable entity that can be transformed into a new, fixed state through controlled intervention. In this context, reforms were viewed as "top-down" approaches to educational change (March, 1994). On the other hand, however, as Cuban (1990) points out, such an approach often led to a cyclical repetition of reforms initiated at the ministerial level, which, while recurring, affect only superficial structures and rarely penetrate the core of pedagogical interaction in the classroom. Cuban (1990) refers to this phenomenon as persistent stability within a network of proclaimed changes.

The current paradigm of educational change reflects the complexity of school systems through the concept of "loosely coupled systems," introduced into organizational theory by Weick (1976). In this understanding, the school is not a monolith; what happens at the level of administration or ministerial policy often has only a weak connection to what occurs in classrooms. This perspective explains why formal changes in education are often implemented only pro forma. In response, theories emphasize the importance of school culture and its changes in terms of the dynamics of the educational environment and institutions. Hargreaves (1995) and Stoll (1998) argue that real change must address the deep-seated beliefs and norms that constitute a school's cultural identity.

Shifting the focus from external management of change to the internal transformation of organizational culture, Connolly, James, and Beales (2011) bring a critical perspective to the discussion, distinguishing between culture as a management tool (functionalist view) and culture as a deep social reality (an interpretive view). Their case study suggests that changing school culture is not a linear process, but a complex interaction between the organization's formal requirements and the informal subcultures present in school life. This perspective corresponds with the work of Schein (2010), who notes that ignoring invisible cultural patterns and subcultures leads to the failure of implementing educational change or reform in the school environment.

A significant shift in the current paradigm is the emphasis on the concept of the learning organization and school leadership, through which Schein (2010) notes that organizational culture and school leadership are two sides of the same coin; leaders must be able to diagnose cultural barriers and transform them in a targeted manner. Senge (2006) expands this perspective to include the disciplines of systems thinking and collective learning. From his perspective, educational change should not be dictated but rather emerge as the result of a shared vision and the continuous development of all stakeholders within the educational institution, based on collective learning and regular reflection. Leithwood and Jantzi (2005) and Fullan (2007), who point out that effective change in an educational institution depends on leaders' ability to delegate power and support the professional autonomy of those experiencing educational change.

2. School As an Organization in the Process of Educational Change

In current scholarly discourse in the fields of educational sciences and sociology, a paradigmatic shift is occurring in the view of the school institution. The school is no longer perceived as a rigid bureaucratic institution, but as a complex, adaptive, and internally differentiated organizational system (Trinidad, 2024). Educational change in the school environment thus does not represent merely an isolated event or the mechanical implementation of a reform but becomes an intrinsic feature of the institutional existence within a given educational institution under the conditions of an evolving reality (Connolly, 2011; Fullan, 2007). The success of this transformation depends on a deep understanding of the synergy between formal structures, the physical environment, and the layers of the naturally evolving culture of the educational institution in question.

2.1 School Culture in the Process of Educational Change and the Risk of "Pseudo-Change"

Kruse and Louis (2009) define school culture as an essential prerequisite for the sustainable improvement of an educational institution. They develop the idea of the school as a "Professional

Learning Community," where a key element is the "deprivatization" of pedagogical practice. This refers to the transition from learning in isolation to an open, collaborative culture. Part of "deprivatization" involves the mutual sharing of experiences, planning and evaluating the educational process, and teachers observing each other's classes, thereby making practice a public and shared endeavour aimed at the collective growth of teachers not only as individuals but also as an educational organization (Aldridge and McLure, 2024). However, this process required a profound shift in the perception of the teacher's identity - from the teacher as an "autonomous ruler of the classroom" to the teacher as a "member of a collaborative team." According to Kruse and Louis (2009), the shift from individual to organizational responsibility is a fundamental hallmark of successful school culture change. In this context, Fullan (2007) notes that cultural transformation is the most difficult phase of educational change because it affects teachers' professional self-confidence. It requires a high degree of mutual trust, which the organization needs to build over the long term, as well as an effective feedback mechanism (Fullan, 2007; Bellei, 2016).

This social perspective is complemented by Engeström's (2001) concept of expansive learning, which emphasizes the need to overcome systemic contradictions within work activities, thereby making learning a tool for the active transformation of the school itself as a workplace. The school as a learning organization thus integrates teachers' individual mastery with social learning, and this approach must also be reflected at the micro-level of the classroom (Sarason, 1990), where Watkins (2005) proposes building classrooms as autonomous learning communities.

A key mechanism for overcoming these barriers and activating the potential of a learning organization is a specific type of leadership that goes beyond the administrative level of implementing educational changes. Leithwood and Jantzi (1999, 2005) identify transformational leadership as an essential prerequisite for changing organizational conditions and increasing the engagement of faculty members. Transformational leaders not only articulate a shared vision but also provide teachers with intellectual stimulation and individual support, thereby building the school's capacity for sustainable improvement. The overall success of the school as a learning organization is thus contingent on the synergy between a clear structural concept, the cultivation of a collaborative culture, and the ability of leaders to navigate the school through the complex micro-politics of power, conflict, and cooperation, as elaborated in detail by Blase (1991).

Connolly, James, and Beales (2011) also highlight the risks associated with the absence of this synergy and the closely related superficial change in school culture. They distinguish between culture as a variable (something an organization "has") and culture as an essence (something an organization "is"). Their research revealed that a so-called "pseudoculture," in which teachers outwardly declared their agreement with the new vision, but in the privacy of their staff rooms continued to practice old routines and maintained a cynical and dismissive attitude toward the administration and any efforts at improvement on their part.

In this context, Connolly, James, and Beales (2011) caution against viewing school culture as a variable that can be simply programmed and implemented in a simplistic manner. It is primarily the result of systematic listening and an understanding of deeply rooted traditions, values, and beliefs, some of which are common to all schools, while others are unique and closely tied to the history and location of a specific school (Krusa and Louisa, 2009; Hargreaves, 1995).

3. Changing School Culture in the Process of Educational Change and School Stakeholders

School culture in the process of educational changes and the subsequent transformation of the school is not merely a passive target of change, but an active force that determines whether a new educational policy will be assimilated, marginalized, or completely rejected (Liddicoat, Scarino, and Kohler, 2018). To gain a deeper understanding of this phenomenon, it is essential to employ the concept of "recultivation," which Fullan (2007) defines as the process of challenging and subsequently transforming the fundamental beliefs and habits that shape educators' everyday reality. Unlike "restructuring," which changes only the formal arrangements (schedule, roles, school regulations), recultivation addresses what Schein (2010) refers to as "basic tacit assumptions." If educational change requires, for example, a transition to inclusion, it may encounter a deeply rooted cultural assumption that students with different needs should be educated separately. Profound change in school culture therefore occurs only when this mental model is replaced by a new, shared belief in the value of diversity (March, 1996; Schein, 2010).

3.1 The Dialectic of Resistance and Cognitive Dissonance in School Culture Change

Profound change in school culture is inevitably linked to the phenomenon of cognitive dissonance and the emotional labour of the actors involved (Kruse and Louis, 2009). Ball (2015), within his micropolitical theory, emphasizes that cultural change is not a consensual process but the result of negotiation and resistance. Teachers' resistance to cultural change is often not a sign of laziness but a defence of professional integrity in an environment that is increasingly dominated by the logic of performativity. If school culture is transformed by external pressure to constantly measure results in any given area (the globalization pressure analysed by Rizvi and Lingard, 2009), a rift emerges between the teacher's humanistic mission and the technocratic demands of the school's governing body. This process can lead to the erosion of the original culture and its replacement by a culture of "reporting," where authentic relationships are replaced by auditable outputs (Stoll, 1998; Deal and Peterson, 2002).

For cultural change to become permanent, it must be institutionalized into daily routines and rituals. According to the concept of professional learning communities (Kruse & Louis, 2009), the key mechanism for deep change is the de-privatization of practice. In traditional school culture, teaching is a private act behind closed doors. Profound transformation requires changing this cultural code into a culture of "radical transparency." This process is also supported by Engeström's (2001) theory of expansive learning, in which an organization overcomes internal contradictions by creating a new, broader object of its activity.

Woolner et al. (2018) also argue that the physical layout of a school is "petrified" culture. If a school professes a culture of collaboration and innovation, yet its spaces continue to reproduce a hierarchical and isolated arrangement, cultural change is materially blocked. A profound transformation of school culture therefore requires a physical reconfiguration that physically prevents a return to old patterns of behaviour and compels educational actors to adopt new, innovative forms of interaction.

Changing school culture through educational reforms is thus not a linear adaptation, but a profound ontological struggle over the institution's identity. It requires a shift from isolation to networking (Trinidad, 2024), from administrative management to transformational leadership (Leithwood & Jantzi, 2005), and at the same time the courage of stakeholders to navigate a period of uncertainty until new patterns of behaviour become established as the new cultural norm (Bellei, 2016).

3.2 School Stakeholders and Their Influence on the Implementation of Educational Changes in the Context of School Culture

The relationship between an organization's structure and its culture is realized through the interactions of key stakeholders, namely teachers, school administrators, and school founders (Schein, 2010). Each of these groups enters the process of educational change with its own interests and degree of power, thereby actively shaping the final form of the organizational culture (Takayama, 2013; Stolp, 1994). School leadership plays the role of a key mediator in this process. As documented by Leithwood and Jantzi (2005), the application of transformational leadership principles is an essential prerequisite for the successful restructuring of cultural patterns. Transformational leaders, unlike transactional managers, do not operate solely through rewards and sanctions, but actively stimulate teachers' intellectual development, formulate a compelling shared vision, and provide individualized support (Ullah and Muslim, 2025). Analysing the leadership of school, Stolp (1994) states that the principal's role does not lie in micromanagement, but in the ability to interpret external changes so that they align with the institution's internal values.

According to Stoll (1998), teachers are the immediate implementers and, at the same time, the strongest guardians of school culture. In his classic sociological study, Lortie (1975) highlighted the conservative nature of the teaching profession, which is shaped by years of socialization in isolated classrooms. Ball (2015) examines teachers' attitudes toward educational changes in this context in detail through the lens of school micropolitics. He debunks the myth of the school as a harmonious community and reveals it as an arena of power struggles, where teachers resist reforms that threaten their professional autonomy, working hours, or established methodological practices (Ball, 2015). School culture thus bears the hallmarks of a defence against external demands for change. On the other hand, Biesta (2015) emphasizes that without teachers' full professional ownership of change, any reform is merely an administrative act. Teachers need to perceive change as meaningful for their own educational goals; otherwise, what Hargreaves (1994) refers to as "forced collegiality" occurs—that is, a state in which teachers mechanically fulfil requirements for teamwork and innovation solely to satisfy external oversight.

Schein (2010) identifies school founders and the broader political apparatus as the third key actor exerting macro-structural pressure on school culture. School funders are the agents of both global and national education policies, which permeate schools through mechanisms such as funding, standardized testing, and inspection activities (Leitwood and Jantzi, 2005). Ball (2012) and Rizvi and Lingard (2009), in their theories on global education policy and neoliberal discourse, note that external actors often impose pressure on schools to prioritize performance and the measurability of outcomes. These demands directly challenge the traditional humanistic culture of schools and force them to transform into data-driven organizations. The school's governing body thus shapes the parameters within which culture can develop, but the actual translation of these macro-level requirements into daily practice is always subject to the institution's local specifics (Portnoi, 2016; Venger, Fontdevila, and Zancajo, 2016).

4. Methodology

This research is based on the classic organizational case study design (Berg 1968), which, however, relies on the researcher's active participation within the organization as a member experiencing a change in organizational culture, as noted by Connolly et al. (2011), with the addition of the methodological framework of the organizational sociology of education (Trinidad, 2024). This involves supplementing the structure of the school environment analysis through a three-level methodological framework for the study of schools, which allows for viewing the organization from multiple complementary perspectives.

4.1 Methodological Framework and Theoretical Basis of the Research Paper's Case Study

In the social sciences, a case study represents a specific research design that focuses on an in-depth examination of a bounded system within its real-world context (Denzin and Lincoln, 2018). According to Stak (1994), cited by Connolly et al. (2011), a case study is not merely a methodological choice but, above all, a selection of what is to be examined - that is, the case as an integrated system. The process of constructing and "creating" a case study consists of precisely delimiting the phenomenon in time and space and subsequently collecting complex data through data triangulation.
The methodological design of Connolly et al. (2011) is defined as an instrumental and longitudinal case study that charts an eight-year period of transformation at a secondary school in South Wales. The data collection itself was based primarily on Beales's (2006) doctoral dissertation and includes a wide range of semi-structured interviews with fifteen teachers, seven students, school governors, and school administrators.
According to Trinidad (2024), integrating his three complementary perspectives perspectives into the methodological framework allows a deeper analysis of how structural constraints and network dynamics within the school respond to factors in the external environment.
The way in which Connolly et al. (2011) structure the case analysis and create individual research areas departs from the traditional chronological description (Lewin, 1947) and moves toward a multi-perspective analytical framework (Beales, 2006). The individual areas of the case study emerged through a deductive-inductive process in which theoretical concepts of organizational culture were systematically applied to empirical data collected at the school. It operates on several interconnected levels that allow for a comprehensive understanding of the dynamics of educational change. At the individual level, the research examines individual teachers' perceptions of change and their emotional responses to new leadership practices (Schein, 2010). The group level focuses on the formation of subcultures and tensions between opponents and supporters of change within the teaching staff. The organizational level subsequently captures changes in the school's structure itself and in systems for monitoring student progress, while the societal (literally, environmental) level considers the influence of broader political pressures and national standards on the internal life of the institution.
The theoretical foundation of the study and its connection to previous research demonstrate a deep grounding in the discipline of organizational theory. A key starting point for the case study by Connolly et al. (2011) was the work of Smircichová (1983), who distinguishes between culture as a variable and culture as a metaphor. Connolly et al. (2011) also draw on the classic models of Schein (2010), whose levels of culture help clarify shifts in the mindset of the teaching staff. The research by Connolly et al. (2011) is also influenced by Alvesson's (1993, 2002) studies on the ambiguity of culture and directly builds on the theme of school improvement represented by Fullan (2007) and Stoll (1998). Weick's (1976) work on schools as loosely coupled systems also contributes to an understanding of transformation processes.

Connolly et al. (2011)'s contribution, compared to these predecessors, lies in the integration of diverse perspectives into a single coherent whole, which demonstrates that successful school change requires simultaneous engagement with reality, interpretation, and power relations within the community. We therefore view the methodological approach of the case study by Connolly et al. (2011), supplemented by the organizational sociology of education (Trinidad, 2024), as suitable for the methodological grounding of the research in our dissertation. At the same time, it provides us with a suitable framework for potentially incorporating areas that will be characteristic of the educational environment and context of the selected school.

4.2 *Case Study – Elementary School Description and Research Findings*

This case study focuses on the transformation of the Alma Private Elementary School (hereinafter referred to as SZŠ Alma), which was established through the process of separating the original public elementary school located at 1 Jilemnického Street in Zvolen, Slovakia. From a regional perspective, it was a catchment-area institution in the Sekier district, established by the City of Zvolen. The school had long faced the stigma of being a segregated institution with a high proportion of students from marginalized Roma communities (MRC), which led to a dramatic decline in enrollment and the local government's consideration of its possible closure due to financial unsustainability.
The formal transfer to the CEEV Živica as the new school sponsor in 2024 was the result of a strategic agreement with the city, intended to save the school from closure. With this step, the new founding body took over not only the infrastructure but also the accumulated financial debts and the school's complex emotional history. Given the starting point, the sponsor decided to implement changes using a "small steps" methodology - gradually and slowly, with an emphasis on continuously fine-tuning what proves effective in practice.
The preparatory phase in the 2023/2024 school year required a more profound intervention in the school's teaching staff, which can be described as a "purge of the teaching staff." During the change process, more than 50% of the original teaching staff left, as their mindset was incompatible with the school's new paradigm and vision. Despite the arrival of new teachers, research observations identified a risk of so-called "teacher isolation." A tendency toward professional isolation and resistance to activities beyond basic duties emerged among some of the new staff. According to the data collected so far, this phenomenon represents one of the main managerial challenges in building a proactive organizational culture, which SZŠ Alma continues to address even after September 2024.
In September 2024, at the time of the official launch of operations under the new identity and the commencement of the research study, SZŠ Alma was in a state of formative dynamics. The school successfully managed its first intake of freshmen, with more than double the number of freshmen enrolling in the first year compared to previous years (34 freshmen in 2024 versus 13 freshmen in 2023). The data collected so far show that active engagement with the community is a fundamental prerequisite for changing the school environment. SZŠ Alma is building a network of relationships with parents and partners in the city of Zvolen through events such as the Education Festival and parent clubs, which are also open to parents of future students. This outward openness helps SZŠ Alma not only transform the school's culture from within but also successfully integrate the school into the city's local ecosystem.
Through informal conversations and our time at the organization, we have so far identified, via structured observation, the key characteristic of implementing educational changes: working with teachers and the school's vision, which is shifting from a traditional structural perspective to an open, collaborative model of cooperation and openness between the teaching staff and school management. Teachers at the school are thus changing over time along with the school's evolving dynamics. Together, they are working on a vision that unites the entire educational organization—so that every child at this school can fulfil their own potential.

4.3 Research Analysis

This case study focuses on the profound transformation of the Alma Private Elementary School (SZŠ) in Zvolen, which was established through the process of separating the original public elementary school on Jilemnického Street in the Sekier district. The implementation of changes was based on a "small steps" methodology, characterized by gradual and empirically verified fine-tuning of processes in practice. As part of the management reconfiguration, two key participatory governance bodies were established: the Board of Directors and the School Council, which ensured expert oversight and transparency of processes.

A quantitative analysis of the data collected to date demonstrates the gradual formative impact of the measures implemented. In September 2024, the school saw a significant increase in interest in enrolment, with 34 first-year students entering the first grade—more than double the 13 first-year students in the previous year, 2023. This success validates the effectiveness of the marketing strategy and the promotion of the institution's new vision to the public. The most significant empirical shift occurred in school attendance among students from the marginalized neighbourhood of Pustý hrad. Over the two-year period under review, there was an average increase in attendance among these students of more than 20%. This shift was achieved through a combination of proactive micro-political interventions, which included regular in-person field visits by teachers directly in the community, localized recognition of students for attendance carried out in their natural environment, and community volunteer projects. These interventions demonstrably stimulated the participation of families from the local marginalized community and led to a 15.5% increase in parental involvement in the school's informal activities, thereby laying the groundwork for breaking down sociocultural barriers between the minority and majority populations.
However, a qualitative analysis of internal networks revealed significant staffing challenges. The preparatory phase in the 2023/2024 school year required a radical overhaul of the teaching staff, during which more than 50% of the original employees left, as their mindset was incompatible with the new inclusive paradigm. Despite the recruitment of new teachers, the phenomenon of professional isolation (*teacher isolation*) was identified through structured observation and informal interviews. A tendency toward isolated professional practice and a certain resistance to activities extending beyond the scope of basic teaching duties emerged among some of the new staff. Building a proactive organizational culture and eliminating this isolating behaviour thus represent the main managerial challenge that school leadership faces even in the implementation phase of educational changes after September 2024.

5. Discussion

The results achieved in the transformation of SZŠ Alma confirm the theoretical postulate that sustainable educational change is not a mechanical product of top-down bureaucratic directives, but the result of a complex institutional reconfiguration in which the organization transforms into a learning community gradually capable of self-reflection (Fullan, 2007; Liddicoat, Scarino, & Kohler, 2018). Research findings to date demonstrate a shift from a traditional structural perspective to an open, collaborative model of cooperation between the teaching staff and school management.
The turnover of teaching staff (over 50%) illustrates deep institutional inertia and the limits of organizational stability. As Schein (2010) notes, organizational culture rests on hidden assumptions that individuals internalize. The departure of half the faculty confirms that school transformation often requires the destruction of the original institutional habitus that hindered innovation. On the other hand, the identified phenomenon of professional isolation (*teacher isolation*) among newly hired teachers reveals the limits of adaptation to change. Teachers facing the emotional baggage associated with the school's historical stigma and high demands on community work tend to retreat into the safety of their classrooms. This mechanism correlates with March's (1994) warnings against formal administrative adaptation that does not touch deeper professional identities. Overcoming this insularity requires a transition toward the thorough de-privatization of pedagogical work, where reflection becomes the collective property of the organization.
Empirical success, in the form of a more than 20% increase in attendance among children from the Pustý hrad community and a 15.5% rise in parental engagement, attests to the importance of connecting the school with its local ecosystem. This approach stands in direct contrast to the neoliberal discourse of performativity (Ball, 2012, 2015), which reduces school success to quantifiable performance testing. Instead, SZŠ Alma focused on cultural reengineering and building social capital directly in the field. As Trinidad (2024), Woolner et al. (2018), and Bellei (2016) emphasize in their synthesis, a successful school turnaround requires the simultaneous synergy of three dimensions: structural coherence, material support, and cultural depth. If measures remained merely on paper, the institution would likely revert to its original state after the initiators' departure, confirming the importance of embedding changes in organizational memory and structures (Biesta, 2015).
The significant contribution of the study in the context of education policy is the demonstration of a causal trajectory from local micro-success to macro-legislative change. While theoretical models of policy transfer (Phillips & Ochs, 2004; Steiner-Khamsi, 2014) often criticize "contextual blindness" in the adoption of global reforms, the case of SZŠ Alma documents the opposite, endogenous process. The school administration's initiative and its practical desegregation outcomes sparked a nationwide professional discussion on equal opportunities in education. This pressure led to an unprecedented

step, in which the Slovak Ministry of Education, at the initiative of the Alma School Board, incorporated a new adjustment of school districts directly into the national reform, effective September 1, 2026. This legislative amendment serves as a systemic measure against the segregation of Roma children and students from socially disadvantaged backgrounds throughout Slovakia. The case study thus provides empirical evidence that local transformational leadership (Leithwood & Jantzi, 2005), supported by effective micro-practice, can reconfigure not only the internal culture of an institution but also national education policy.

6. Conclusion

A deeper look into the "turnaround trajectory" reveals that successful schools in the context of educational reforms in socially disadvantaged environments did not succeed thanks to a single miracle method, but rather due to the coherence of a system comprising multiple measures. Bellei et al. (2016) describe a school that radically transformed its results by implementing a system of intensive feedback based on "coaching techniques and questions" (Instructional Coaching). In this model, each teacher received brief but highly specific weekly feedback from an experienced colleague based on direct observation of teaching in their classroom. The data showed that effective educational change must be supported by specific micro-practices that are integrated into the daily routine of teachers' lives at school. The transformation of a school as an organization thus represents a dialectical process between stability and change. As research by Trinidad (2024), Woolner et al. (2018), and Bellei (2016), successful school transformation requires simultaneous attention to three dimensions: structural coherence, material support, and cultural depth. Without an understanding of the interconnections between physical space, informal networks (relationships), and professional identities in the broader context beyond the school, attempts at educational change in the context of school transformation remain merely at the level of formal administrative change—without a real impact on the quality and sustainability of the educational process (March, 1994; Schein, 2010).
True school change is therefore a process of comprehensive institutional reconfiguration in which the organization becomes a learning community capable of mutual reflection, feedback, and self-transformation at the level of human and teaching capital (Liddicoat, Scarino, & Kohler, 2018; Fullan, 2007).

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Intercultural Communication Models Revisited: The Richard Lewis Model, the Generation Alpha, and Beyond

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Abstract

This paper examines the contemporary relevance of traditional intercultural communication frameworks, focusing on the Richard Lewis Model, in understanding the emerging cultural dynamics of Generation Alpha and future Generations. Developed in the 1990s, the Lewis Model categorizes national cultures into linear-active, multi-active, and reactive behavioural types, offering a practical and widely used tool for interpreting cross-cultural communication patterns. Despite its continued value in explaining communication tendencies grounded in stable national contexts, the model faces limitations when applied to Generation Alpha, whose cultural formation is profoundly shaped by digital immersion. Their communication behaviours further diverge from traditional cultural categories due to the influence of online ecosystems. While the Lewis Model retains relevance in contexts involving intergenerational interaction or institutions structured around pre-digital cultural paradigms, its explanatory power is limited when interpreting Gen Alpha's microcultures. These emerging cultural formations are transnational, dynamic, and often detached from the nation-based behavioural stereotypes foundational to the model. As such, this paper argues that future adaptations of the Lewis framework should integrate digital-native dimensions, to more accurately capture the intercultural realities of digital-era generations, and *address the identified gap by critically reassessing the Richard Lewis Model through the lens of Generation Alpha while incorporating the conceptual contributions of the Mirror Model proposed by J. Huisman.*

Keywords: *Cross-cultural Communication, Intercultural Models, Gen Alpha, R. Lewis Model, the Mirror Model*

Introduction

Cross-cultural communication models have long served as foundational analytical tools for understanding differences in values, behaviours, and interaction styles across national and organizational contexts. Since the late twentieth century, influential frameworks such as Hofstede's cultural dimensions, Trompenaars and Hampden-Turner's cultural dilemmas, Erin Meyer's *Culture Map*, and Richard Lewis's cultural typology have shaped both academic inquiry and professional practice in international management, education, and global collaboration. Developed in an era characterized by comparatively stable national cultures, face-to-face interaction, and institutionally bounded learning environments, these models reflect social conditions that preceded widespread digitization and platform-mediated communication.

Hofstede's model conceptualizes culture through empirically derived dimensions such as individualism–collectivism, power distance, and uncertainty avoidance, offering a comparative national lens grounded in large-scale organizational data. Trompenaars and Hampden-Turner extend this approach by framing culture as a series of value-based dilemmas through which societies negotiate universalism versus particularism and achievement versus ascription. Building on these traditions, Erin Meyer translates cultural differences into pragmatic managerial axes, including low- versus high-context communication and egalitarian versus hierarchical leadership styles. Despite their conceptual and practical contributions, these frameworks share a common assumption: culture is predominantly shaped by nation-state socialization and remains relatively coherent and stable across generations.

Richard Lewis's Model of Cross-Cultural Communication diverges from dimension-based approaches by emphasizing observable communicative behaviour. By categorizing cultures as linear-active, multi-active, or reactive based on interaction styles, time orientation, and conversational flow, the model offers an intuitive and behaviourally grounded framework. Its practical appeal has led to widespread adoption in diplomacy, international negotiation, and corporate training. However, the Lewis Model remains deeply anchored in national cultural typologies and implicitly assumes continuity of communicative norms within national boundaries—an assumption increasingly challenged by contemporary sociotechnical conditions.

The emergence of digitally native generations, most notably Generation Alpha (born approximately from 2010 onwards), raises critical questions regarding the continued applicability of traditional intercultural frameworks. As the first generation socialized entirely within digital ecosystems, Generation Alpha's cultural formation is shaped less by national institutions and more by global platforms, algorithmic curation, peer-driven content creation, and participatory online communities. Their communicative practices evolve within gaming environments, social media platforms, and short-form video cultures, where meaning is compressed, symbolic, rapidly shifting, and often detached from geographic or national reference points. These conditions complicate the assumption that cultural behaviour can be reliably inferred from national affiliation alone.

While existing literature acknowledges the transformative impact of digitalization on communication, comparatively little attention has been paid to how generational change disrupts nation-based intercultural models, particularly those—such as the Lewis Model—that rely on behavioural typologies rooted in pre-digital social structures. This constitutes a notable gap within intercultural communication and international management research. The challenge is not merely one of updating examples, but of reconsidering whether nation-centric explanatory logics remain sufficient for interpreting communication in digitally mediated, transnational, and generationally fragmented contexts.

In response to this limitation, recent conceptual developments—such as the Mirror Model proposed by J. Huisman—seek to extend traditional intercultural frameworks by incorporating competencies that reflect the realities of digital-native generations. The Huisman Mirror Model complements the Lewis typology by introducing a corresponding set of dimensions focused on internal, adaptive, and future-oriented capacities, including self-reflection, digital communication, collaboration, creativity, and ethical citizenship. Rather than replacing nation-based models, this mirrored approach reinterprets intercultural communication as a dynamic interplay between externally observable cultural behaviours and internally developed competencies shaped by digital environments and globalized experiences.

This paper addresses the identified gap by critically reassessing the Richard Lewis Model through the lens of Generation Alpha while incorporating the conceptual contributions of the Huisman Mirror Model. It argues that although the Lewis framework retains relevance in intergenerational interactions and institutionally structured environments shaped by pre-digital norms, its explanatory power is limited when applied to platform-centric, algorithmically mediated microcultures. By foregrounding generational dynamics, digital mediation, and fluid identity formation—and by integrating the mirrored competency-based perspective proposed by J. Huisman. This study contributes to ongoing debates on the future of intercultural communication theory and proposes conceptual directions for extending the Lewis framework to better capture the realities of digital-era generations.

1. Reassessing the Richard Lewis Model in the Context of Gen Alpha

The Richard Lewis Model of Cross-Cultural Communication has been widely used to interpret intercultural interaction by categorizing national communication styles into linear-active, multi-active, and reactive cultural types (Lewis, 2006). Its behavioural emphasis and practitioner-oriented design have made it particularly influential in international business, diplomacy, and cross-border collaboration. However, the emergence of digitally native generations—most notably Generation Alpha—raises important questions regarding the model's contemporary explanatory power, particularly in increasingly digital, transnational, and generationally fragmented communication environments.

1.1 Explanatory Capacity of the Lewis Model for Gen Alpha

The Lewis Model retains limited but context-dependent relevance for understanding Generation Alpha's communication behaviours. In institutional and intergenerational settings—such as formal education systems, family structures, and traditional organizational environments—communication norms continue to reflect national cultural patterns transmitted by older generations (Hofstede et al., 2010). In these contexts, Lewis's behavioural typologies remain useful for interpreting expectations related to hierarchy, conversational rhythm, and interactional etiquette.

However, when applied to Generation Alpha's peer-based and digitally mediated communication, the model's explanatory scope is significantly constrained. Lewis's framework presupposes relatively stable national cultures and prioritizes face-to-face interaction, synchronous dialogue, and linear conversational flows (Lewis, 2006). By contrast, Generation Alpha's communication is predominantly asynchronous, multimodal, and shaped by platform affordances rather than rather than national conventions (Boyd, 2014; Danesi, 2017). Consequently, while the Lewis Model can explain inherited and institutionalized communication behaviours, it is insufficient as a standalone framework for

interpreting the communicative practices emerging among digital-native cohorts. communicative identity among Generation Alpha is fluid and situational. Individuals frequently shift styles depending on platform, audience, and algorithmic context, resulting in communicative behaviours that cannot be consistently aligned with a single national-cultural profile (Jenkins, 2006; Boyd, 2014). These dynamics fundamentally challenge the nation-centric assumptions underpinning traditional intercultural models.

1.2 Towards a Theoretical Extension of the Lewis Model: The Mirror Model

Generation Alpha's communication behaviours are more strongly shaped by digital platform cultures than by national cultural affiliation. While national culture continues to influence communication within formal and institutional settings, digital platforms increasingly function as primary sites of communicative socialization. This suggests that intercultural frameworks privileging nation-based explanations without integrating digital and generational dynamics risk misrepresenting the communicative realities of emerging generations.

The Mirror Model proposed by J. Huisman can be understood as a contemporary extension and critical reframing of the Lewis cultural typology, which originally categorized national communication styles into linear-active, multi-active, and reactive orientations based primarily on observable behavioural and interactional norms (Lewis, 2006). While the Lewis model has been influential in intercultural communication studies, critics argue that its reliance on relatively stable national profiles does not fully capture the fluid, hybridized, and digitally mediated identities emerging in the 21st century (Holliday, 2011). Huisman's Mirror Model addresses this gap by introducing complementary dimensions that reflect the competencies and socio-cultural conditions shaping Generation Alpha, a cohort growing up in an environment characterized by digital connectivity, globalization, and rapid knowledge exchange. In this mirrored framework, traditional dimensions such as task orientation, emotional expressiveness, and listening styles are balanced by internal and reflexive capacities including followship, self-reflection, and ethical awareness, suggesting a shift from externally observable cultural patterns toward internalized, adaptive capabilities.

Followship, for instance, repositions individuals not only as leaders or communicators but as responsive participants within distributed networks, aligning with contemporary leadership theories that emphasize shared responsibility and collaborative agency (Uhl-Bien et al., 2014). Self-reflection becomes crucial in navigating complex identity constructions, particularly in digital environments where individuals continuously curate and renegotiate their presence (Turkle, 2015). Furthermore, digital communication competence is foregrounded as a core dimension, recognizing that intercultural interaction increasingly occurs through mediated platforms requiring multimodal literacy and sensitivity to algorithmic contexts (van Dijck, 2013). The inclusion of cultural and ethical citizenship reflects the growing importance of global responsibility, sustainability awareness, and digital ethics in shaping how individuals engage across cultural boundaries (Ribble, 2015). Creativity and critical thinking are positioned as central cognitive skills that enable individuals to move beyond cultural stereotypes and engage in innovative problem-solving, thus countering the deterministic implications often associated with static cultural models (Deardorff, 2006). Collaboration and life skills further emphasize adaptability, resilience, and interpersonal competence, highlighting that effective intercultural actors must operate within dynamic, interdisciplinary, and often virtual teams.

Importantly, the Mirror Model suggests not replacement but augmentation: the original Lewis Model remains a useful for understanding macro-level cultural tendencies, while the mirrored dimensions capture micro-level, developmental, and future-oriented competencies. This dual-layer approach aligns with calls in intercultural scholarship to move beyond essentialist frameworks toward more processual and competency-based models (Spitzberg & Changnon, 2009). In this sense, Huisman's model reflects a paradigm shift from "culture as fixed profile" to "culture as evolving practice," acknowledging that generational change, technological integration, and global interdependence necessitate new analytical tools. By embedding skills such as critical thinking, creativity, and ethical engagement within the intercultural framework, the Mirror Model not only updates the Lewis paradigm but also reorients it toward education, youth development, and lifelong learning in a digitally interconnected world. Consequently, this approach provides a more holistic and future-relevant understanding of intercultural competence, particularly suited to Generation Alpha's lived realities and the demands of an increasingly complex global society.

2. Discussion and Conclusion

This paper set out to reassess the contemporary relevance of the Richard Lewis Model of Cross-Cultural Communication in light of the emergence of Generation Alpha as the first fully digital-native generation. The analysis demonstrates that while the Lewis Model remains conceptually robust for interpreting communication in institutionalized and intergenerational contexts, its underlying nation-centric assumptions limit its explanatory power in digitally mediated environments.

One key contribution of this study lies in highlighting generational socialization as a critical but underdeveloped dimension in intercultural communication theory. Existing models—including those of Hofstede (2010), Trompenaars and Hampden-Turner (2012), Meyer (2014), and Lewis (2006)—implicitly assume cultural continuity across age cohorts. The findings presented here challenge this assumption by illustrating how Generation Alpha's communicative practices are shaped less by national cultural heritage and more by participation in global digital ecosystems. In this context, the Huisman Mirror Model provides a useful conceptual extension by explicitly incorporating generationally shaped competencies—such as self-reflection, digital communication, and collaboration—that are largely absent from traditional frameworks.

Furthermore, the results underscore the importance of platform cultures as emergent cultural units. Unlike national cultures, platform-based microcultures are fluid, transnational, and algorithmically shaped, producing communicative norms that evolve at a pace incompatible with static cultural typologies (Boyd, 2014; Couldry & Hepp, 2017). This insight extends prior discussions of digitalization in communication studies by explicitly situating platforms as cultural environments rather than neutral channels. Huisman's Mirror Model aligns with this perspective by recognizing digital platforms not only as contexts of communication but also as formative environments that shape competencies such as multimodal literacy, ethical awareness, and adaptive interaction.

From a theoretical perspective, the proposed extension of the Lewis Model—operationalized through the Huisman Mirror Model—offers a way forward that avoids both cultural determinism and technological reductionism. Rather than privileging either national culture or digital context, the mirror framework conceptualizes communication behaviour as the outcome of an interaction between external cultural patterns; captured by the Lewis typology and internal, adaptive competencies captured by Huisman's Mirror Model dimensions. This dual-layered approach preserves the strengths of Lewis's behavioural focus while addressing the realities of contemporary intercultural interaction, where individuals operate simultaneously within inherited cultural frameworks and rapidly evolving digital environments.

By proposing a conceptual extension in the form of the Huisman Mirror Model, this paper responds directly to calls for updated intercultural frameworks capable of addressing contemporary global communication realities. The mirror model complements the Lewis typology by integrating generational dynamics, platform-based microcultures, and digitally shaped competencies, thereby offering a more holistic and future-oriented analytical lens. It emphasizes that intercultural communication in the digital era must be understood not only through observable behavioural patterns but also through reflective, adaptive, and cognitively embedded capacities.

Further research could also integrate AI-mediated communication, including human–AI interaction and algorithmically scaffolded learning environments, as Generation Alpha's communicative landscape will increasingly involve non-human interlocutors. In this context, the Huisman Model provides a useful foundation for exploring how competencies such as critical thinking, ethical awareness, and adaptive communication evolve in hybrid human–machine environments.

Finally, interdisciplinary collaboration between intercultural communication, digital sociology, and human–computer interaction research will be essential to further develop and empirically validate integrated models such as the Lewis–Huisman framework. Such efforts will strengthen the theoretical and practical relevance of intercultural communication models in an increasingly complex, digital, and generationally dynamic world

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Metaphors: Vocabulary of Success and Failure in Career Guidance

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Abstract

Language both reflects and constructs social reality. As Ludwig Wittgenstein observed, "the limits of my language mean the limits of my world," underscoring the role of language in shaping perception. In the context of work, evolving terminology reveals shifting understandings of careers, success, and failure. Metaphors are central to this process, offering accessible frameworks through which complex career theories and practices are communicated and interpreted. Common metaphors such as "lane," "path," "journey," and "ladder" frame careers as linear or progressive trajectories, while "theatre" and "roles" emphasize performance, adaptability, and identity across the lifespan. In contrast, metaphors such as the "glass ceiling" and "glass cliff" draw attention to structural barriers and unequal advancement opportunities [1]. These linguistic constructs do more than describe career development; they actively shape how individuals interpret experiences, assess achievement, and respond to setbacks. This presentation examines how success and failure are constructed and negotiated through widely used career metaphors and theoretical perspectives, including Chaos Theory of Careers [2]. By analysing the language embedded in both popular discourse and career theory, it highlights how metaphor influences meaning-making in career development in an increasingly complex and uncertain world.

Keywords: *metaphors, success, failure, career theories, career development*

1. Introduction

There are many metaphors related to career development and progression. Some of them show how much people can advance, others refer to how well employees can do. All of them try to define success and failure and set the boundaries within which one can move. Inkson [3] has seen metaphors as an appealing way to present career issues to different groups of people and analysed the different perspectives of looking at careers as legacy, craft, seasons, matching, path, network, theatre, economic, narrative. In this paper, we will refer to some of the common phrases related to what people see as next step in their career experiences and see how certain career theories translate their supposed meaning. Career theories offer us perspectives on how the world of work operates, how we can prepare for it, what gives us job satisfaction [4]. Career management in the past was mostly seen as an organisational task, but by the late 20th century the shift was moved to the individual endeavours, to self-direct their career navigation although the circumstances might often be stressful, such as the COVID period, that often hides the organisational traps [5]. Some career theories have a central position on the discourse and have influenced the way career practitioners approach career guidance and counselling. We will also try to combine the key features of these metaphors to show an outline of competencies that an employee would find beneficial in their career development.

2. Road to Progression: Career Ladder and Individuals

Finding the best possible fit between individual vocational interests and jobs is considered one of the basic points of career decision and planning [6]. Beginning with determining the personality type (Realistic, Investigative, Artistic, Social, Enterprising, Social), understanding the skills related to each one of those types and matching them to occupations helps clarify a clear progression route. Looking at such a linear progression, advancing within an organisation is often compared as climbing a ladder. It is one of the most common references showcasing a linear advancement, implying that everyone starts at the bottom and remains static until reaching the next rung in the ladder in an always linear route towards the top. There is a sequence of steps within a hierarchy, and this is clearly denoted in the job title, for example 'trainee', manager, partner. To follow this traditional career road, it makes sense to employees to find an institution that aligns to their values and remain in the same organization perhaps until retirement [8].

2.1 Career Ladders and Institutions

But if individuals can move up the ladder, then we assume that there must be a ladder in the first place set up by the organisations. Although organisations, such as Higher Education Institutes, present clear pathways of upward career advancement with job titles denoting it, the questions that arise are how the organisations make the ladder accessible and whether there is only one career ladder for all employees in an organisation. Beyond individual characteristics and skills advancing in the career ladder could be an institutional/organisational issue, as there could be organisational barriers that make it difficult for employees to progress. Although this is an issue that has been dealt through affirmative actions and legislation, trying to protect people from biases and make room for them to be judged on the basis of competence and efficiency rather than personal characteristics, establishment malfunctions show the existence of stereotypes. First, noticed in 1970s [8] and then as the feminist movement grew stronger more widely researched in the following decades, the research of the invisible barriers that women employees face in advancing their career beyond middle management, known as the glass ceiling [9]. It showed that despite the wider entrance of women in the workforce, vertical advancement in the career ladder was not easy and this also obstructed by glass walls, as women were usually segregated within specific roles in their organisations, such as working at HR departments, and could not move to other roles -lateral ones- which would give them experience and skills to progress into top management roles. Even when women took leadership roles, often there were extraordinary circumstances, such as an organization in crisis and a high risk of failure involved [10]. It has often been said ‘think managers – think men’, ‘think crisis – think women’, implying either that the soft skills of women could be more beneficial in times of crisis or that women leaders could embrace change more easily [11]. Closely related was the sticky floor term, describing how employees were stuck in entry jobs without many career promotion opportunities. Later, these terms involved to show not only barriers in promotion but also low wages and salaries across the whole workforce organization and how individuals might need constrained to ‘stay in their lane’.

3. Cycles of Career Development

Looking at the next steps in work experiences is not only a matter of opportunities but a combination with the life stage that people are, as career development cannot be viewed as separate from self-development. As Super [12] proposed in his Career Development Model, self-concept develops through time and experiences and distinguished five stages: growth, exploration, establishment, maintenance, decline. Highlighting the importance of change over time, vocational maturity is not defined to a certain chronological time, as individuals move through these stages at career transitions. One could argue that careers are like cycles or seasons in which change is not only inevitable but should also be welcomed in a life cycle of continuous learning. As sometimes, individuals will make great strides in growth, while others won’t, skills such as flexibility, resilience and adaptability will help them grow in those cycles.
The Kaleidoscope Career Model (KCM) [13] shows the fluidity of the needs of people and that decisions are based on three parameters: authenticity showing the alignment between the individual’s values and the employing organisation’s values; balance between work and non-work demands, such as family, carer’s role and leisure time; challenge showing the desire of increased responsibilities and advancement. At a given point of time, more emphasis could be placed on one of the elements while another might play more important role in other career decisions. Although these differences refer to individuals, research between the career needs of different generation can show the different career needs, it can also be used to examine generational career needs in the workplace [14].

4. Life Storytelling

When the next step is not as obvious as a promotion, it is often an individual task to create a framework within which to visualize their next steps. A different perspective focusing on how individuals construct their careers is presented by the Career Construction Theory [15]. Instead of thinking of career as a linear activity progressing through stages, career construction theory is more interested in how individuals build and cross bridges between personality and career. Career is better seen as a journey as the pathway may be unknown, but the destination is clear as you are progressing towards a goal. In the journey, one might find curves that set them back and hide the destination, shortcuts that may lead to the destination faster or lead to a dead end and then one must find their way back. Adaptability becomes a key skill to help individuals choose and make sense of their job, adapt to the environment.

Pathways as a metaphor show the many choices that one has in front of them, adding dynamic to the career journey, where strategy has a key role to play. Advancement does not need to be vertical, as it could be lateral and to navigate it a map is important. The destination of a path could be unclear as there are so many choices and therefore uncertainty and loneliness could be severe disruptions to this journey.
A powerful way of understanding the motivation and the meaning behind choices comes through storytelling as individuals try to restructure their past experiences, traumas and career transitions. Through these stories the individual creates a narrative that tells how education, experience, connections and work converge and how the past not only shapes the present and the future, but also how the present becomes a catalyst of understanding of the past. Therefore, the past does not dictate the future, but the perception of the past, the present and the future can be constructed by the person, and the narrative of the story can change directions.
Storytelling is as unique as every individual and is built on their own inspiration and interests and career is one of the components that brings meaning to the whole life story. Savickas [16] using life designing counselling explains the importance of moving from the self-concept to the identity co-construction, where the individual becomes not only actor and agent in their life, but an author. On the other hand, as storytelling is not always a narration of actual events, but the interpretation of events, the individual projects a subjective rather than an objective understanding of events and situations.

5. Openness to the Unexpected

If we compared career planning as an equation, with the hope of handling all the variables so that the trajectory of a career could be organized and turned around as imagined in advance, there would be the variable of life situations that would make the result totally unpredictable. The theory of Planned Happenstance (PH) [17] recognises that chance events are inevitable and serendipity can impact career planning. However, luck is not a determining factor, it is sustainable key traits that make individuals turn chance into career opportunities: curiosity to explore new learning opportunities; risk-taking in pursuing action even when the outcomes are unsure; persistence to overcome obstacles; flexibility to adapt to new situations and change attitudes; optimism in seeing the potential of new experiences.
Knowing the right people and building a network or a web does not necessarily mean that these connections will be tools that can be used in advancing an individual's career. As a person's network grows over time and so do their skills, contacts and expertise. Making connections, asking questions, learning from other people's experiences and curiosity along with risk-taking can turn chance events into turning points. Although such an approach highlights the importance of readiness to make the most of unexpected events, it leaves a big margin to things beyond one's control and potentially more things for people to self-blame, if they don't have or can't have opportunities for advancement.
Although each one of the PH skills is important, synergy between them relies upon other variables. For example, optimism allows people to understand that there are endless possibilities and therefore revisiting past and present experiences helps to make connections between roles and experiences, but if people perceive barriers, then their curiosity diminishes [18].
The complexity of the modern world with global connectivity is also central in the Chaos Theory of Careers (CTC) [19]. It acknowledges the many factors that influence career choices and the constant interaction between individuals and environments invites us to think outside the traditional career development practices that try to predict long-term planning and get prepared to handle unplanned events. It rejects the idea that typical career pathways follow a straight upward line and resemble them more to a drunken man's stagger' [20]. Therefore, seeing patterns and being ready to see them change is a way not to be afraid of complexity but work with it by cultivating an adaptability mindset, understand failures and see the positive things they hide. This moves individuals from long-term planning to planfulness, which is a process of constant reviewing and tailoring of plans, consisting of devising, revising, abandoning, pausing, re-launching, finessing, and adapting them. We would expect that the agency that CTC gives to individuals to make the most of any situation could be at the same time empowering and overwhelming, as it demands individuals to be constantly alert and ready to change course.

6. Synthesising Metaphors

Trying to make sense of the metaphors we presented (Fig.1), we would say that individuals should know themselves and have a toolkit of skills that they can use as it seems fit Having a careers toolkit is a metaphor used both for employees as well as career practitioners. It relates to a wide range of skills and

competences that we need to succeed. Like a handyman does not reply to one or two tools but uses a combination depending on the task, the employees should develop an array of skills, which will be used on their own or in combination with others. Beginning with their intrinsic motivation is essential to know their values and actively see how they align with the values of the organisation they work for or want to work for. Being motivated with the purpose of their work can lead to job satisfaction and successful transitions during their life.

They should also be reflective, taking stock and trying to analyse their past experiences not on a self-reprimanding or blaming way, but in a constructive way to see the influences of people and events in their decisions and visualise their future aspirations. Trying to plan everything is almost impossible because the environment changes, personal factors interfere, as life is totally unpredictable. Constant revision of the initial plans to match the data at any given time is more sensible but requires constant awareness of opportunities and may be beyond the comfort zone at some times.

Individuals need also to understand that it is not only way to success or that qualifications that matter and that their work experience and achievements can never be seen objectively. There will always be subjective interpretations, and that they need to approach their work life as holistically as they can. Work cannot be detached by personal life, as work life is an organic part of the self-concept. Accepting that in the work life there will be ups and downs, detours, stagnation periods, toxic environments and other problems, but they should see all these with optimism and find the inner resources to turn them into opportunities for meaningful career moves. Resilience and adaptability are positive concepts on how to handle failure and feeling less fearful at the face of failure seems to be not just a personality trait that some have more in abundance of others, but a teachable feature.

From the side of organisations, it shows that they should take into account stressful situations and how they affect their employees. HR departments should take into serious consideration the employees' wellbeing, mental health, as well as being proactive in embracing inclusion and diversity [21]. Organisations should therefore address their responsibility in career advancement of individuals and provide multiple opportunities for career professional development, networking and advancement.

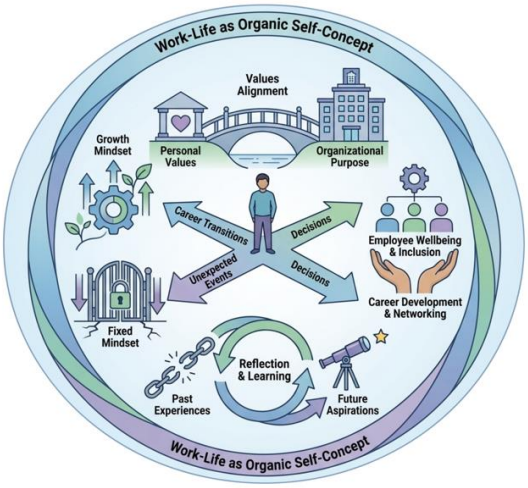


Fig.1. Work-Life as Organic Self-Concept - image created via Biorender

7. Discussion – Points to Consider

This paper is not an extensive analysis of metaphors in career development, but focuses on metaphors related to transitions, which can describe mobility, unexpected events and decisions. In different times of our life and career phase, different metaphors might be more appropriate than others. It is important to see whether these metaphors link to a growth mindset or whether they trigger self-limiting beliefs and are closer to the fixed mindset. Using language that supports development of personal agency where reflection and lifelong learning are highlighted as part of success and part of turning failure into success. At the same time, it is not only individuals but also systems that enable success or failure. It should not be only the individuals who should be invited to move from thinking of restrictions, but organisations as well, which should change into a more enabling approach. Preparing for the unexpected, adapting to diverse contexts and rewriting the life story are attitudes that could help individuals understand success and failure not as terminal points, but as parts of the cycle.

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Expanded Payoff Matrices and Drawing: Design Methods for Creating Value through Positive Sum Design

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Abstract

Creativity can be characterized as a process that produces novel and useful outcomes. Positive Sum Design seeks to harness this kind of creativity in order to generate the greatest aggregate value for all stakeholders, eschewing scarcity in favor of abundance, and overcoming zero sum bias. Collaborating with undergraduate design engineering students, these design principles were workshopped into a set of design methods. These design methods enhanced the creative process by supporting divergent thinking - the ability to generate many different outcomes. Participants were able to generate an impressive range of possibilities through iterative sketching, as they mapped those possibilities in relation to each other through the use of an expanded payoff matrix (based on the traditional payoff matrices taken from Game Theory). Participants were given a scenario involving a limited resource (an umbrella). When first encountered, the conditions seemed unable to support the needs of all stakeholders. However, through the implementation of these Positive Sum Design methods, participants were able to create positive sum value and generate diverse solutions to the given problem.

Keywords: *Positive Sum Design, Design Process, Divergent Thinking, Design Education, Game Theory*

1. Introduction

It is raining hard outside. You and a co-worker are about to leave the office to go home for the evening, but you both realize you did not bring an umbrella. As luck would have it, another coworker has left an extra umbrella that you can borrow. You have several immediate options. You can take the umbrella, which will keep you dry, but your co-worker will get wet. They can take the umbrella, which will keep them dry, but you will get wet. You can share the umbrella, but it is not big enough to keep both of you completely dry, although you will both get less wet than if you had nothing at all. Or, in the interest of fairness, you both agree that no one should have an umbrella. What would you do? We gave this scenario to undergraduates in order to initiate a discussion about the different design interventions that might be possible. The question has an implicit utilitarian premise. How might you produce the best possible outcome for the most people? In order to answer that question, one must consider who the players are, what their incentives are, and what the best strategies they might take to achieve what they all see as their best interest. The results could produce a zero-sum game, as would be the case if one or the other worker chose the umbrella for themselves at the expense of the other. But the question we are ultimately posing to the students is a matter of how the given situation might be reframed into a scenario where the needs of everyone can be met.

This logic is the foundation of a design approach called Positive Sum Design. Positive Sum Design asserts that good design seeks to create value between agents (positive sum), rather than simply re-allocate value (zero sum). The design methods presented herein reflect this ethical stance, which is to say, that design should be put in the service of producing positive outcomes for all stakeholders. The ethical question might be further simplified: Is it ethically permissible to pursue a zero-sum strategy when positive sum options exist? Or to put it even more prosaically: why allow losers when a bit more creativity can help everyone win according to differing incentives and context? These exercises attempt to frame that metaethical question, by demonstrating that options for win/wins do exist, even when not immediately recognized, if a proper framing is cultivated and applied. These design methods attempt to provide some of that framing or reframing, as the case may be. These design methods enhance the creative process, critiquing bias for competition and scarcity towards a preference for the design of affordances that foster cooperation and abundance, for the positive gains of everyone involved.

Two people under one umbrella may seem to be competing for limited space—but staying dry doesn't require standing under the same cover. What appears to be a zero-sum scenario can be reframed to uncover overlooked solutions that benefit everyone. This insight reflects the ethical shift at the heart of

Positive Sum Design: by rethinking constraints, questioning assumptions, and enabling collaboration, designers can uncover hidden value and create outcomes that serve all stakeholders.

1.1 Design Methods: The Sketch and the Pay-Off Matrix

Conventional design engineering often assumes scarce resources and emphasizes trade-offs. Positive-Sum Design (PSD) challenges this by broadening constraints and promoting cooperation to generate outcomes where all stakeholders benefit. This reframes design from local optimization ("my user wins") to maximizing system-wide utility ("the system wins"). In education, PSD fosters a shift from zero-sum thinking to collaborative, multi-party problem-solving.
This paper introduces design methods that help students create positive-sum solutions—those that enhance collective value. Developed through critical design workshops, these methods integrate sketching and payoff matrices to support divergent thinking and challenge assumptions of scarcity. Together, these tools help reframe context, incentives, and resource availability, making PSD more accessible and actionable in both academic and professional settings.
Beyond sketching with paper and pen, Positive Sum Design design methods stimulate divergent thinking by employing modes of representations taken directly from Game Theory. Workshop participants were encouraged to map out the possibilities identified through their initial drawings as a payoff matrix. A payoff matrix is a table that maps the outcomes for each player in a strategic game, given the combinations of strategies and incentives chosen by all players [16]. The payoff matrix enables a bird's-eye view of stakeholder interactions across contexts and incentives, complementing drawing's focus on specific solutions. Together, they reveal possibilities that may otherwise go unnoticed.
A payoff matrix maps out the possible incentives and outcomes of a strategic interaction between multiple players. It is a tool for visualizing how scenarios between different agents might interact and has been a foundational in economics and political science since its formalization by von Neumann and Morgenstern in Theory of Games and Economic Behavior [21]. In traditional Game Theory, the payoff matrix enables analysis of cooperation, competition, and strategic equilibrium, e.g. the Nash equilibrium [16]. These matrices clarify how individual strategies align or conflict with the outcomes of others, helping reveal zero-sum, negative-sum, or positive-sum scenarios. While game theory traditionally focuses on rational actors in simplified conditions, its models are increasingly leveraged in fields beyond economics, including sociology, evolutionary biology, and design [4].

1.2 Expanding Value through Divergent Thinking

Creativity can be characterized as a process that produces outcomes that are both novel and useful [20]. Positive Sum Design (PSD) fosters creativity, in part, by integrating traditional design methods with insights from Game Theory in order to reframe problems and maximize collective value. Using tools such as sketches and payoff matrices, PSD fosters creativity through divergent thinking—generating multiple varied possibilities and applying those possibilities to useful applications. In his American Psychological Association (APA) presidential address, Creativity, Joy Paul Guilford defined divergence as the moment when "the thinker must do much searching around, often in several directions at once, for ideas that are both numerous and varied" [10]. Subsequent work corroborates Guilford's claim that idea generation is an exercise of cognitive aptitude. Meta-analyses show that people who earn higher scores on divergent-thinking tests are, on average, more likely to achieve creative success later in life [13] and to have their work rated as more creative by expert judges [18]. While correlations between divergent thinking and creative success are moderate, they remain significant. Convergent thinking, by contrast, focuses on narrowing options to find the most effective solution. Both models are essential to creativity and can be strengthened through visual methods that make abstract thinking tangible.
Divergent and convergent thinking entered scholarly discourse through J.P. Guilford's 1950 APA address, where he argued that creativity consists of multiple cognitive processes. He later formalized these ideas in his Structure-of-Intellect model, identifying fluency, flexibility, originality, and elaboration as core divergent thinking skills. In the 1960s, E.P. Torrance translated Guilford's framework into practical tools by developing the Torrance Tests of Creative Thinking (TTCT). These tests, comprising verbal and figural tasks, evaluate creativity through Guilford's four dimensions and have demonstrated predictive validity in longitudinal studies [20]. One notable figural task involves transforming repeated circles into distinct objects, directly assessing flexibility and originality. This concept evolved into the 30 Circles Challenge, popularized by Stanford professor Bob McKim and later adopted by IDEO, serving as a rapid exercise to enhance creative fluency under time constraints. Whereas TTCT circles are scored analytically, the 30-Circles exercise is typically used formatively to help teams experience the

difference between idea quantity and quality. Ultimately, the exercise exemplifies Guilford's divergence and convergence axes of creativity.
Complementary tools capture other facets of creative cognition. Sarnoff Mednick's Remote Associates Test (RAT) taps convergent insight by asking solvers to discover one word linking three remote associates, emphasizing tight semantic closure rather than generative breadth [20]. Alternatively, Teresa Amabile's Consensual Assessment Technique (CAT) sidesteps psychometrics entirely. Panels of field experts rate real products for creativity, bringing domain specific standards into the evaluation process [20]. Collectively, these measures provide a multifaceted toolkit for studying how people navigate from many possibilities to a single, high utility solution.
Sketching stimulates and concretizes divergent thinking. Studies underscore that drawing actively expands the outcome space of possible solutions by leveraging the very cognitive traits that support divergent thinking [19] [13]. Sketching plays a vital role in fostering divergent thinking and creativity. Boldt and Strub [2] found a strong link between conceptual flexibility and drawing creativity, highlighting sketching as a pathway to novel ideas. In design engineering, sketching supports "value exploration" by revealing hidden needs and enabling shared understanding [11] [5]. Visual tools invite critique, spark analogies, and build trust—critical for Positive Sum Design. Even quick exercises like the Circles Test show how manipulating constraints visually encourages flexible, collaborative thinking.

1.3 Game Theory and Human-Centered Design

Designers are well accustomed to employing user scenarios to better understand what they are designing and who they are designing for. Human-centered Design (HCD) emphasizes empathy and iterative development to meet user needs [3]. Tools such as user journey maps and user personas are just some of the tools used in HCD to better understand who an individual user is and how they might navigate the circumstances and constraints of a proposed situation. As noted by Don Norman, one of the leading proponents of HCD, the aim of HCD is to create technology and products that are "usable, useful, and desirable" [15].
Traditional payoff matrices are useful because of the constraints they offer. They focus the scenario around a given number of possible players, strategies, and outcomes [1]. However, constraints also limit the kinds of behaviors and choices that can occur, and ultimately the utility or value that can be enjoyed by the players, albeit in varying proportion to one another. Constraints are useful in helping to define the design problem, which in turn can be iterated upon and further developed. Within the design process, it is often necessary or desirable to find a balance between thinking within the given constraints, and also thinking beyond them. Failure of imagination can result if the scope of the problem is too limited.
While Human-Centered Design focuses on individual users, Positive Sum Design shifts attention to multiple agents and how their interactions affect collective value. To support this broader perspective, we introduced an expanded payoff matrix—a tool that goes beyond the traditional game-theoretic model, which tends to converge on a single optimal outcome. Instead, our matrix encourages divergent thinking, helping designers explore a wider range of perspectives and outcomes. By mapping user behaviors, incentives, and interactions onto this matrix, designers can "reframe the game" to uncover new possibilities. This foundation supports visual ideation: sketching tangible interventions within richer, more nuanced scenarios. When combined with prototyping and refinement, this approach enables interventions that increase value for all stakeholders.

2. Workshop: Applied Positive Sum Design

To develop and evaluate Positive Sum Design (PSD) methods in practice, we conducted two complementary workshops at Brown University: a two-hour studio session involving 13 undergraduates and an asynchronous online workshop which welcomed participants from a wider range of academic backgrounds. Both formats led participants through a scaffolded sequence that moved them from zero-sum reasoning to win-win framing, demonstrating how structured play, visual ideation, and game-theoretic framing can foster creative, cooperative problem-solving in design education. The workshop followed a structured progression that blended brief concept overviews with interactive practice. After a short comparison of positive-sum and zero-sum frameworks, participants undertook a series of hands-on exercises designed to encourage divergent thinking and collaborative problem-solving.
First, a Haystack Exercise ("How would you find a needle in a haystack?") was used to measure divergent thinking, with responses scored for fluency, flexibility, and originality. Next, students tackled the primary Umbrella Scenario: they sketched solutions and mapped strategies on payoff matrices to design mutually beneficial outcomes. Creative outputs were evaluated using the Consensual

Assessment Technique (CAT) and Torrance Tests of Creative Thinking (TTCT). The session concluded with a group discussion and a reflection survey to gauge shifts in perception and strategy.
Throughout the session, the instructors highlighted the contrast between zero-sum assumptions and positive-sum possibilities, stressing how reframing constraints and employing divergent thinking can lead to integrative solutions. Students participated actively and collaboratively, frequently expressing surprise at the innovative win-win ideas that emerged and noting how these activities made abstract theory tangible, thereby deepening their understanding of PSD. In the first iteration of the expanded payoff matrix exercise, students ranked four introductory scenarios— keep the umbrella, give it away, share it, or decline it—and then translate these rankings into a traditional payoff matrix [Figure 1].
Explaining their choices allowed them to link quantitative rankings with qualitative reasoning. The cohort subsequently discussed varying incentives and explored possible Nash equilibria, each player's optimal strategy given the other's, highlighting how different frames influence cooperative outcomes.

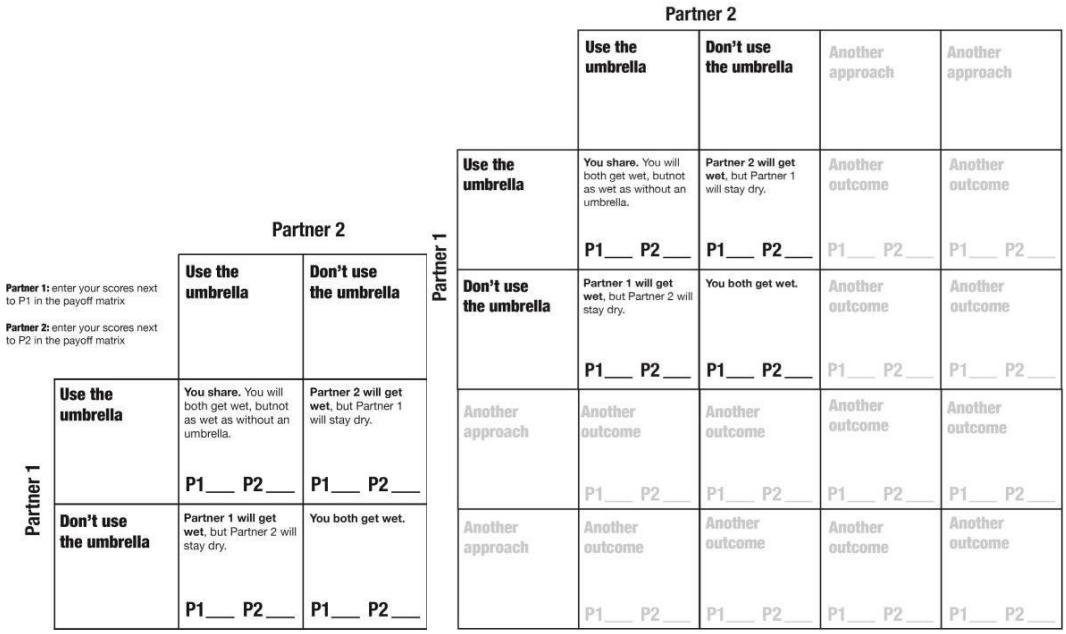


Fig. 1. Payoff Matrix vs Expanded Payoff Matrix

The second iteration introduced an expanded payoff matrix. Like the traditional version, this matrix uses rows and columns to assign values to different interactions between agents. However, whereas the traditional matrix focuses on convergent thinking, identifying a single optimal outcome, the expanded matrix encourages divergent thinking by reframing constraints and exploring possibilities beyond the initial conditions. Students first brainstormed additional options, then mapped these options onto the expanded matrix to visualize the broader set of potential outcomes. After a round of discussion and collaborative refinement by the entire cohort, students were asked to concretize and visualize their newly generated options, adding specificity and detail to each proposed design intervention. [Figure 2]

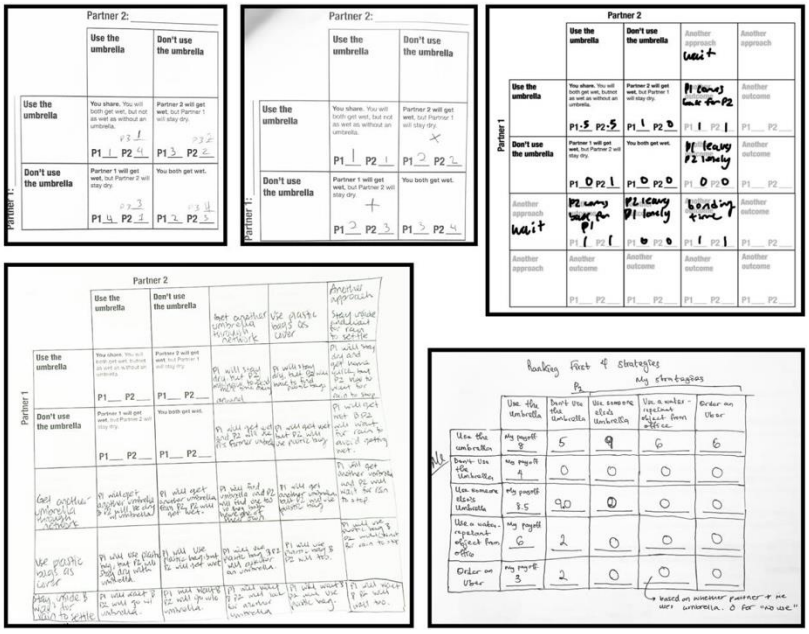


Fig. 2. Student Payoff Matrix

Drawing is a robust cognitive tool for exploring creativity and value generation. Recent studies have shown that drawing tasks activate divergent thinking pathways and allow creators to explore abstract concepts spatially and relationally [2]. In PSD contexts, drawing allows participants to test how a design might perform for multiple users, evolve with needs, and curate an intended experience. These sketches are not merely illustrations, but rather strategic moves within a game of collective gain.

To evaluate these drawn solutions, we can apply tools developed in developmental research [20]. The Consensual Assessment Technique (CAT) offers a method where experts evaluate individuals' creative performance on open-ended tasks. Domain expertise and contextual problem-solving ground the CAT method, distinguishing it from other scales of creativity. In the workshop's scenario, participants are tasked with proposing creative alternatives to the limited choices presented by the traditional zero-sum setup: either one person benefits or both incur partial losses.

To apply CAT rigorously, recruit a panel of independent judges familiar with design, creativity research, or human-centered problem-solving. Judges do not compare drawings to a fixed rubric, but instead rely on their respective understanding of creativity and social value. The strength of CAT is in capturing subjective yet consensus-driven assessments, allowing for nuance that rigid scoring schemes might miss. By applying CAT to these sketches, researchers and facilitators can simultaneously identify which ideas are "creative" and which foster a positive sum outcome. This, in turn, allows for an empirical yet holistic way to populate a new kind of payoff matrix– one in which outcomes are optimal, collectively meaningful, and adaptable.

To complement CAT, the Torrence Tests of Creative Thinking (TTCT) offer a structured framework for assessing participants' creative thinking during the workshop. Originally developed by E. Paul Torrence, TTCT evaluates four dimensions of creativity: fluency, originality, flexibility, and elaboration. In the context of our design workshop, TTCT provides a structured way to assess the creative output of participants as they engage in divergent thinking activities, such as sketching prototype solutions. This standardized test is therefore highly relevant in the workshop context as an objective means to evaluate the creativity of the design solutions generated, offering a benchmark for creative performance beyond subjective judgment.

Within the TTCT dimensions, fluency is measured by the number of distinct ideas a participant produces, indicating their ability to think beyond conventional solutions. Flexibility refers to the diversity of conceptual approaches reflected in their sketches, particularly in how they address PSD principles. Originality is assessed by the uniqueness of a solution within the pool of responses. Ideas that appear infrequently or diverge significantly from the norm are marked as more original. Elaboration evaluates

the depth and clarity of the participant's thinking, rated on a scale from minimal to comprehensive, based on the extent of explanation and contextualization provided.

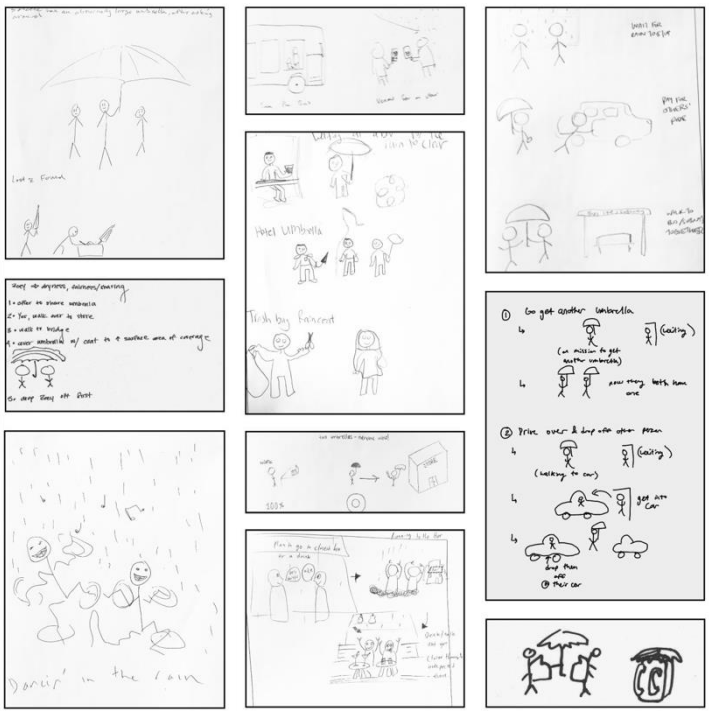


Fig. 3. Selected student sketches for the umbrella scenario

Together, these dimensions offer insight not just into how creative a response is, but how effectively it addresses the real-world challenge at hand. Divergent thinking, in this context, is not measured in isolation but in terms of its capacity to produce value, relevance, and mutual benefit.

3. Discussion

Despite the modest size of the workshops, participants proposed a thoughtful range of creative strategies, grouped thematically into several categories. Some participants attempted to redesign the object itself, proposing technical design solutions such as double umbrellas or a portable drone system, for example. Others attempted to reframe the given constraints in order to discover new ways of addressing the need, such as shifting the functional fixedness of adjacent objects in order to adapt them to serve that desired utility. Participants discovered much ready material to work with by opening themselves up to other possibilities, such as protecting themselves from the rain with objects ranging from trashcans and trash bags to jackets and newspapers. And still others attempted to reframe the utility of the object by expanding the incentives beyond what was initially apparent. These participants not only asked, "What do I want and how do I get it?" but perhaps a more foundational question, "Why do I want what I want?" Some of these participants realized that staying dry might not be the best possible outcome at all. They discovered that it might be more desirable to enjoy the rain, for example (e.g. dancing in the rain) or use the circumstances as a ready reason to take a sick leave the following day.

The workshops occasioned a wide variety of approaches to the given problem, with most falling into these three categories. Some tried to improve the design of the umbrella itself. Others expanded the resources available to them by applying the given constraints to the broader context in which they found themselves. While still others fundamentally questioned the premise of the given goal in order to explore other ways to understand their needs. All of these strategies lead to the discovery of otherwise unrecognized value.

Nearly everyone's initial instinct was to share and avoid the "all wet" outcome, but altruism vs. self-interest varied by group. Weather severity, health, distance, and the relationship history of the participants could lead to a change in the ranking order. Buying, borrowing, waiting, splitting a cab, or improvising rain gear often transformed a competitive zero-sum dilemma into a cooperative win/win. Viewing the umbrella as a resource that can shift from a "rival" or "excludable" good to "public "good (by sharing or adding another umbrella) led stakeholders to constructive tensions, which ultimately

encouraged higher-value mutual solutions. Communication between stakeholders, including the use of visual representations such as rough sketches, were key to this shift. Drawing not only helped to generate new possibilities that were novel and useful to all stakeholders, but aided cooperation and coordination between those stakeholders as well.
Our analysis also compared traditional payoff matrices with expanded payoff matrices. The expanded payoff matrix helped stakeholders map out and visualize the available options, and helped stakeholders identify where reasonable trade-offs could be made. This allowed all stakeholders to shift from a zero-sum scenario, where wins come at the expense of losses, to positive sum games, by growing resources, reframing the constraints, and redefining the need.
In the initial zero-sum scenario, participants generally defaulted to solutions that maximized their own dryness at the expense of the other, mirroring the expected Nash equilibria. For example, Group A had two participants share the umbrella while the third member resorted to using a trash bag for coverage. One could argue that these outcomes extrapolate a focus on self-interest and resource scarcity. As a result, there are limited payoff options and minimal mutual benefit.
When prompted to use the expanded payoff matrix, the diversity and utility of ideas noticeably increased. Group B proposed supplementary factors to the scenario to bypass the initial constraints. Their ideation included collaborative solutions, such as using the umbrella by one member of the team to seek resources for the rest of the group, e.g. trekking to dry environments such as a nearby hotel to call an Uber or otherwise using the single umbrella to search for additional resources that allowed for coverage of all stakeholders.
Group C devised a systemic solution that went beyond the immediate scenario, designing a workforce umbrella-sharing program. Alternatively, Group F and E focused on technical improvements to the umbrella itself, sketching a dual umbrella prototype where the product adjusts based on height and circumference. The expanded payoff matrices reflected higher aggregate utility in all these scenarios. All parties stayed dry, or at least less wet, while also adapting resources and reallocating risk. Across the six teams, participants produced an average of 8–10 distinct ideas beyond the standard two options. Not all were sketched; however, in almost all cases, the act of drawing clarified assumptions, exposed contrasting features, and invoked more novel combinations, consistent with research showing visual ideation boosts flexibility and elaboration.
In our initial pilot evaluation, we focused primarily on the TTCT subscales of flexibility and originality, since these dimensions most directly mapped the PSD principles of mutability of constraints and multivalence of utility. However, fluency (the sheer number of ideas generated) and elaboration (the depth and detail of those ideas) are equally critical facets of creative potential. In future work, we hope to incorporate timed fluency tasks where participants produce as many illustrations as possible to capture how volume drives discovery. Likewise, the hope is to integrate elaboration prompts by asking participants to annotate or color-code their top ideas, documenting the “how” and “why” behind each solution. These richer artifacts can then be scored both for idea count and for the granularity of their execution, yielding a more holistic profile of divergent thinking. Integrating sketches and payoff matrices enabled participants to quantify and communicate differential gains. The use of sketches and payoff matrixes within the design process helped stakeholders generate and capture new value by developing unconsidered possibilities and mapping the outcomes of those possibilities against each other.

4. Conclusion

Drawing and mapping complement each other, the former allowing for the generation of varied, individual possibilities, with the latter allowing for a systemic view of how those possibilities relate to each other as a whole. Although the sample for these pilot workshops were small, the results offer promising evidence for the efficacy of these design methods in producing greater aggregate value for all stakeholders. The expanded payoff matrix, in conjunction with visual design methods such as sketching, can convert perceived scarcity into positive-sum outcomes.
The fundamental ethical question that PSD poses is to ask if it is permissible to play a zero-sum game when possibilities for playing positive sum game either already exist or can be developed by means of a creative engagement with the problem? Is there an ethical obligation to challenge one’s own bias towards zero sum framing? Is there an ethical obligation to overcome failures of imagination? Is there an ethical obligation to cultivate creativity? Is one compelled to think creatively in order to expand the available resources for all stakeholders, and facilitate cooperation and communication over direct competition?
PSD methods attempt to address this need. These design methods give designers and stakeholders a means by which they might visualize the complexities that arise from the differing incentives and

changing constraints between the interplay of multiple users within a given context. PSD offers designers tools for enhancing divergent thinking and expanding the available resources against assumptions of scarcity. These insights can then be further ideated and visualized and prototyped, as the design process culminates in the best possible solutions for all stakeholders.

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Scenario-Based Teaching of Water-Stress Communication in Business Education: A Quasi-Experimental Study in Bulgaria

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Abstract

Business education still lacks transferable instructional models for teaching low-salience sustainability risks that students do not readily recognize as immediate managerial and communication challenges. This paper presents and pilot-evaluates a competency-based instructional framework that uses water stress in Bulgaria as a context for teaching risk interpretation, stakeholder reasoning, and public communication before crisis conditions emerge. The Bulgarian case is instructionally relevant because official statistics show that 5.8% of the population experienced drought-related water-supply restrictions in 2024. A quasi-experimental design is implemented with two intact groups of fourth-year Business Management students. The comparison group follows an active debate-based case-learning format, whereas the intervention group completes a scenario-based sequence combining simulations, serious-game-inspired mechanisms, stakeholder role-play, and structured message mapping. The intervention is designed to strengthen engagement while integrating analysis, decision-making, and communication under uncertainty. The study examines two outcomes. First, it evaluates the quality of student discussion during structured deliberation on water-stress scenarios, focusing on argument quality, evidence use, stakeholder reasoning, and decision coherence. Second, it assesses applied communication competence through the quality of message maps and drafted public-facing statements, with attention to clarity, specificity, actionability, and trust-preserving framing. Results from the 24-protocol R1-scored corpus indicate high discussion quality in both conditions, mixed applied communication performance, and actionability as the clearest instructional bottleneck. The paper contributes an implementable teaching design, an assessment-oriented competency framework, and a transferable model for embedding sustainability-risk education in business curricula.

Keywords: *business education; sustainability risk; water stress; scenario-based learning; communication competence*

1. Introduction

Water stress is not only a hydrological condition but a governance problem that becomes socially consequential through coordination, credibility, and public-facing decisions. At the global policy level, water security is also framed as directly connected to prosperity and peace [1]. In low-salience settings-where aggregate resource availability and reservoir infrastructure can foster a narrative of adequacy-capability building is often delayed until late-stage restrictions or incidents occur. This makes early-stage communication and management decisions critical: they can either stabilize expectations and mobilize preventive action or accelerate escalation through confusion, mistrust, and stakeholder conflict.

The Bulgarian case is instructionally relevant because official environmental statistics report that in 2024, 5.8% of the population experienced water-supply regimes due to drought, including 5.0% under seasonal regimes and 0.8% under year-round regimes [2]. The same source reports substantial regional variation: the most affected districts were Lovech (56.3%), Pleven (51.1%), Targovishte (33.8%), and Pernik (17.8%) [2]. The national statistic is used here as an educational anchor rather than as a full hydrological diagnosis: it helps students interpret a low-salience sustainability risk as a managerial communication problem before a crisis becomes publicly visible.

In this paper, communication-management risk under water stress is defined as the coupled risk that (a) decisions under uncertainty fail to coordinate stakeholders, allocate responsibilities, and trigger timely preventive actions, and (b) communication choices reduce trust, invite misinformation, or fail to translate decisions into actionable public guidance-thereby increasing the likelihood and cost of escalation. This definition intentionally treats communication as a governance mechanism rather than a post-hoc public-relations activity.

The educational challenge follows directly: business management curricula train managerial decision-making under uncertainty, stakeholder coordination, reputational-risk assessment, and public-facing communication, yet water stress is often treated as a technical or environmental topic rather than a managerial communication problem. To make preparedness teachable in a low-salience context, instructional design must render latent risks cognitively salient and require assessable artefacts that demonstrate competence, not only attitudes.
The contribution of this paper is educational rather than hydrological. It offers and pilot-evaluates an artefact-based teaching design for making a low-salience sustainability risk actionable in business education. The model links scenario-based deliberation, stakeholder reasoning, decision mapping, and public-facing message production to transparent assessment criteria. The present findings are reported as pilot descriptive evidence from the complete 24-protocol R1-scored corpus and still require independent second-rater scoring before any confirmatory claim can be made.

2. Literature Review and Conceptual Framework

2.1 Low-Salience ("hidden risk") Communication for Drought and Water Stress

Slow-onset hazards such as drought and water stress are difficult to communicate because their onset is diffuse and often not readily perceived. Weitkamp et al. [3] argue that in "wet" climates drought risk may lack personal relevance and is filtered through heuristics and cultural expectations; they propose a framework for drought risk communication where publics may not perceive the risk. For education, the implication is practical: teaching must first establish interpretive frames-what to notice, what signals mean, and what actions are proportional-before competence can be expected.

2.2 Water Services, Trust, and Crisis Communication as Governance

Water services are uniquely trust-sensitive among utilities because they relate directly to health and daily life. Utility crisis communication guidance emphasizes clarity, transparency, empathy, and disciplined messaging to sustain public trust [4]. In the present framework, these principles are not treated as "soft" skills; they define performance criteria for applied risk communication: actionability, uncertainty disclosure, and decision-message alignment.

2.3 Simulation and Serious-Game-Inspired Learning for Water Governance

Scenario-based instruction is relevant to this design because it structures situated practice around realistic tasks and decision contexts in higher education [5]. Simulation and serious-game approaches are increasingly used to train water governance because they enable participants to practise coordination and decision-making under uncertainty, including stakeholder conflict and time pressure. In the water-governance literature, game-based approaches are proposed as tools to explore relational practices and complex system trade-offs [6], [7]. Recent serious-game work on drinking-water contamination emergency response explicitly models communication and multi-stakeholder coordination [8]. At European policy level, JRC guidance and training tools for water reuse governance further legitimize structured role-play and serious games as capacity-building mechanisms for risk-based planning [9], [10].

2.4 Constructive Alignment, Rubrics, and Artefact-Based Assessment

To meet education-conference expectations, the study follows constructive alignment: learning outcomes are mapped to learning activities and to assessment rubrics that score observable artefacts [11]. This assessment orientation is consistent with sustainability-competence education, which emphasizes integrated competencies and the challenge of assessing them through suitable tools [12], [13]. This alignment is important because the paper evaluates not only whether students discuss water-stress scenarios, but whether they produce evidence-aware decisions and public-facing messages that can be assessed consistently.
Analytic rubrics are appropriate for this purpose because they make criteria visible and allow separate scoring of complex performance dimensions. Jonsson and Svingby [14] conclude that rubric-based scoring can enhance reliability especially when rubrics are analytic, topic-specific, and supported by exemplars or rater training; however, rubrics do not guarantee valid judgment by themselves. Brookhart [15] similarly emphasizes that effective rubrics require criteria that match the intended performance and

meaningful descriptions of performance levels. These cautions inform the pilot framing of the present study: the rubrics are used diagnostically, while reliability and validity claims are deliberately limited at this draft stage.

Table 1. Competency-Artefact-Assessment Alignment

Competency domain	Student artefact	Assessment focus
Evidence-aware deliberation	Decision protocol, rebuttals, decision map	Argument quality, evidence use, uncertainty handling
Stakeholder coordination	Stakeholder analysis, decision package	Interests, constraints, responsibilities
Decision coherence	Decision package and map	Feasibility, timeline, trade-offs
Applied risk communication	Message map, CAP statement	Clarity, actionability, transparency, trust, alignment

2.5 Research Questions

Because the analysis uses a pilot R1-scored protocol corpus, the study is guided by descriptive research questions rather than confirmatory hypotheses:
RQ1: What patterns of discussion quality are observable in the 24-protocol R1-scored corpus?
RQ2: What patterns of applied risk-communication competence are observable in the 24-protocol R1-scored corpus?
RQ3: Which rubric dimensions reveal the clearest relative instructional bottlenecks for future teaching iterations?

3. Methods

3.1 Design, Setting, and Instructional Timeline

We used a pilot quasi-experimental teaching design with two intact sections in a fourth-year Business Management course (total N = 30 students), organized into six teams of five students. Each section included three teams, corresponding to the comparison group and the intervention group, respectively. Sections were treated as intact groups rather than randomly assigned; within each section, teams were formed to maintain comparable team size and functional diversity. The sequence was delivered across four consecutive approximately 90-minute sessions. Both conditions shared the same core pedagogy-debate with opposing viewpoints, written decision packages, plenary rebuttal, and decision mapping-which served as an active control. The intervention condition added simulation-enhanced and serious-game-inspired mechanisms, role constraints, timed checkpoints, information updates, and structured risk-communication outputs. In this manuscript, the design is treated as a pilot comparison of artefact quality and diagnostic instructional patterns, not as a confirmatory evaluation of intervention effects.

Table 2. Instructional Session Timeline

Session	Instructional focus	Common active-control activities	Additional intervention elements and artefacts
Session 1	Water-stress risk framing and evidence interpretation	Opposing-viewpoint debate; evidence and assumptions log; initial decision package	Scenario framing; stakeholder role cards; preliminary message map
Session 2	Stakeholder reasoning, responsibilities, and trade-offs	Rebuttal; stakeholder analysis; decision criteria and trade-off mapping	Role constraints; timed checkpoint; structured stakeholder-to-message translation
Session 3	Decision-making under evolving information and operational uncertainty	Updated decision package; feasibility review; responsibility allocation; revised decision map	Information update round; time-pressure checkpoint; separately captured Session 3 artefacts for full-corpus scoring
Session 4	Public-facing communication and decision-to-message alignment	Final decision map; communication output; plenary comparison of decisions	CAP-structured public statement; source-of-truth and update-cadence requirement

Because intact groups were used, the design should be interpreted cautiously. In education research, quasi-experimental designs require attention to baseline equivalence and selection risk [16]. The present draft-stage analysis does not claim confirmatory intervention advantages; it reports descriptive pilot evidence from the R1-scored protocol corpus.

3.2 Conditions: Active Control and Augmented Intervention

Opposing viewpoints as an instructional device. The use of two deliberately opposing positions was a pedagogical technique to surface assumptions, clarify criteria, and force trade-off articulation. To minimize the risk of a false dichotomy, positions were framed as analytic poles rather than normative extremes: teams were encouraged to identify hybrid options during reconciliation and to document accepted trade-offs explicitly in the decision map. Instructors monitored for caricatured or moralizing arguments and redirected teams to evidence-based constraints, stakeholder interests, and feasibility criteria.
Comparison group (CG): debate-based case learning. Students split into two opposing positions, produced written decision packages, engaged in rebuttal, and created a decision map capturing criteria, trade-offs, and expected outcomes. Communication elements were documented but not explicitly scaffolded through role constraints, timed checkpoints, or CAP-structured public messaging.
Intervention group (IG): augmented scenario-based sequence. The intervention retained the same debate structure but added (i) stakeholder role-play through role cards with objectives and constraints, (ii) decision checkpoints under uncertainty through timed rounds and information updates, including the Session 3 update round, and (iii) explicit production of risk-communication artefacts: a message map and a CAP-structured public statement oriented to clarity, actionability, transparency, and trust preservation.
CAP refers to a Caring-Action-Perspective structure: acknowledge concern, specify actions, and provide factual context including uncertainty and update cadence.

3.3 Data Source and Artefact Capture

Student protocols were collected at the end of each session and served as performance artefacts. The protocol template required evidence and assumptions, opposing viewpoints and rebuttals, stakeholder reasoning, a decision package with responsibilities, a decision map, and communication output. The full teaching sequence generated raw course materials, including session worksheets and supporting artefacts; however, the reportable corpus for the present draft comprises 24 consolidated, anonymized, and R1-scored team-session protocols from the scoring sheet. No values are inferred beyond the scored protocol records.

3.4 Outcomes and Rubric Scoring

Unit of analysis. The unit of analysis is the team–session protocol (one protocol produced by one team for one session). All rubric scores are assigned at the protocol level.
Two primary outcomes were assessed using analytic rubrics applied to student protocols. O1 Discussion quality included four criteria: argument quality, evidence use, stakeholder reasoning, and decision coherence. O2 Applied risk-communication competence included five criteria: clarity, actionability, transparency/uncertainty disclosure, trust-preserving framing, and decision-message alignment. Each criterion was scored on a 0-4 scale with calibration anchors for scores 0, 2, and 4; scores 1 and 3 represented intermediate performance.

3.5 R1-Scored Protocol Corpus and Analysis Plan

The analysis evaluates feasibility of artefact capture, rubric sensitivity, and diagnostic instructional patterns; it does not estimate intervention effects.
The scored corpus comprises 24 protocol-level observations and is used as a pilot artefact corpus rather than as a student-level dataset. Scores are analysed at the protocol level, and the same teams can contribute multiple protocols across sessions. The corpus therefore supports descriptive diagnostic analysis of artefact quality, but not independent-case inference or causal estimation.
At this draft stage, the rubric is used primarily as a diagnostic assessment tool to identify specific performance strengths and weaknesses, especially actionability, responsibility assignment, and decision-to-message alignment.

The instructional design generated 24 team-session observations (6 teams × 4 sessions). The R1-scored corpus comprises 24 protocol-level observations: 12 comparison-group protocols and 12 intervention-group protocols. Because the same teams can contribute multiple protocols across sessions, these observations are repeated team-level traces rather than independent cases; therefore, condition is treated only as a descriptive grouping variable.
The next strengthening step should report independent second-rater scoring, inter-rater reliability, baseline equivalence checks, and baseline-controlled comparisons where appropriate. Until that workflow is completed, the present results should be read as R1-scored pilot descriptive evidence.

3.6 Reliability and Scoring Workflow

The defensible workflow for stronger reporting requires two independent raters, calibration with rubric anchors, and reporting inter-rater reliability. At this draft stage, the 24 protocol-level observations were scored by one preliminary rater only. Inter-rater reliability is therefore not reported, and the findings are interpreted as descriptive pilot evidence. A second-rater procedure and inter-rater reliability estimates should be completed before the corpus is used for stronger claims. Rater blinding was not implemented at this preliminary stage; the condition labels remained visible in the working scoring file, so expectancy bias is treated as a limitation.

3.7 Ethics

Students were informed that protocol artefacts could be used for research in anonymized form; participation in research use was voluntary and did not affect course grading. Protocols were anonymized for research scoring, stored securely, and reported only in aggregate or through de-identified excerpts. Research scoring was separated from course grading, following informed-consent principles appropriate for educational research.

4. Results

Results are reported as descriptive patterns and should not be interpreted as causal intervention advantages. The condition labels are retained for transparency of artefact origin, not for estimating treatment effects. The current results report the complete 24-protocol R1-scored corpus used in this draft: 12 comparison-group protocols and 12 intervention-group protocols.

4.1 Pilot Descriptive Results

The Table 3 corpus comprises all 24 R1-scored team-session protocols (12 CG, 12 IG) and includes all four instructional sessions. Results remain descriptive because protocols are repeated team-level traces rather than independent cases.
The table below reports protocol-level descriptive statistics. O1 is the mean of four discussion-quality criteria; O2 is the mean of five applied risk-communication criteria. Condition statistics include n, arithmetic mean, sample standard deviation, and observed range.

Table 3. Pilot Descriptive Results and Diagnostic Interpretation (24 R1-scored protocols)

Dimension	CG	IG	Diagnostic note
O1 Discussion quality	n=12; M=3.17; SD=0.19; R=3.00–3.50	n=12; M=3.25; SD=0.28; R=2.75–3.75	High; small IG advantage.
O2 Applied risk communication	n=12; M=3.55; SD=0.26; R=3.20–4.00	n=12; M=3.45; SD=0.19; R=3.20–3.80	Mixed; no IG advantage.
A2 Evidence use	n=12; M=3.25; SD=0.87; R=2.00–4.00	n=12; M=3.50; SD=0.67; R=2.00–4.00	Modest IG advantage.
B2 Actionability	n=12; M=3.00; SD=0.60; R=2.00–4.00	n=12; M=2.83; SD=0.39; R=2.00–3.00	Main bottleneck.
A3 Stakeholder reasoning	n=12; M=3.75; SD=0.45; R=3.00–4.00	n=12; M=3.83; SD=0.39; R=3.00–4.00	High; possible ceiling.
B3 Transparency	n=12; M=4.00; SD=0.00; R=4.00–4.00	n=12; M=3.92; SD=0.29; R=3.00–4.00	Ceiling/near-ceiling.

Descriptive reporting note. M = mean; SD = sample standard deviation; R = observed range. Median values are omitted from Table 3 to reduce visual density; the analysis remains descriptive and protocol-

level. The table is based on 24 R1-scored protocols in the uploaded scoring sheet; the R2 scoring pack is not yet available, so inter-rater reliability and reconciled scores are not yet reportable.
Criterion-level inspection indicates strong stakeholder reasoning in both conditions and a ceiling or near-ceiling pattern in transparency/uncertainty disclosure. This may reflect effective task scaffolding, but it may also indicate a ceiling effect that should be addressed in future rubric refinement. The clearest relative instructional bottleneck was B2 Actionability: students were generally able to communicate clearly and acknowledge uncertainty, but needed more support in specifying concrete actions, responsibilities, time frames, and source-of-truth references.
The descriptive results answer the research questions as follows. RQ1: discussion quality is high in both conditions, with a small descriptive IG advantage in O1 and evidence use. RQ2: applied risk-communication competence shows a mixed pattern and does not support an intervention advantage in the 24-protocol R1-scored corpus, although decision-message alignment is descriptively higher in the intervention group. RQ3: actionability is the clearest relative instructional bottleneck, especially specification of responsible actors, concrete actions, deadlines, and a source-of-truth update channel. Overall, the R1-scored pilot results support the feasibility of artefact capture and rubric-based scoring. They also indicate where the instructional design should be strengthened: not primarily in general clarity or transparency, but in actionability and decision-to-message translation under scenario constraints. No causal claims are made from the pilot corpus.

5. Discussion

This pilot analysis explored whether simulation-enhanced and serious-game-inspired elements produced observable diagnostic patterns beyond a strong baseline pedagogy. A key observation is that debate-based case learning with opposing positions, written decisions, and decision mapping can already elicit robust deliberation in a low-salience risk topic. This matters for business education because the task approximates managerial work: interpreting incomplete evidence, coordinating stakeholders, weighing reputational consequences, assigning responsibilities, and translating decisions into public-facing guidance.
The intervention was designed to scaffold applied risk communication through message maps and CAP-structured public statements. However, the 24-protocol R1-scored corpus showed a mixed O2 pattern rather than a consistent intervention advantage. This finding is instructionally useful because it suggests that structured communication artefacts do not automatically improve public-facing communication unless actionability, responsibility assignment, and update cadence are enforced more explicitly and practised repeatedly.
The clearest diagnostic result concerns actionability. Across the pilot corpus, students more readily produced clear, transparent, and trust-preserving messages than concrete guidance specifying who should do what, when, and through which follow-up channel. Future iterations should therefore strengthen the CAP statement template by requiring explicit next-24-to-72-hour actions, responsible actors, update cadence, and source-of-truth references.
The paper's strongest contribution is therefore diagnostic: the artefact-based rubric identifies actionability (B2) as a recurring relative instructional bottleneck, especially in the translation from transparent messaging to operationally specific public guidance.
The design-oriented value is that the assessment criteria point directly to refinements that can be implemented in the next teaching iteration before a full-corpus evaluation is attempted.

5.1 Practical Implications

Actionability scaffolds (immediate classroom use):
• Require every public statement to include a 24-72h action line, responsible actor(s), a deadline/review point, and a single source-of-truth update channel.
• Use a micro-checklist for students: Actor-Action-Deadline-Update channel; if any element is missing, revise before submission.
Instructors can implement the approach with minimal infrastructure by adopting four components: (1) opposing-viewpoint debate to surface assumptions relevant to managerial decision-making; (2) written decision packages with explicit responsibilities and reputational-risk implications; (3) decision mapping to force coherence, stakeholder coordination, and trade-off documentation; and (4) message mapping plus a short public statement to operationalize transparency, trust, and public-facing communication. Rubrics enable assessment without audio/video recording, reducing logistical burden.

The pilot results suggest one refinement for immediate classroom use: the communication artefact should not merely ask for a clear public message; it should require a concise action line specifying actor, action, deadline, update channel, and next review point. This requirement would target the weakest observed O2 dimension without making the exercise substantially more complex.

5.2 Limitations and the Most Defensible Framing

The full 24-observation protocol corpus is represented in the R1-scored scoring file, and no values are inferred from missing or unscored artefacts. Nevertheless, the evidence remains pilot and descriptive because the unit is the protocol, not the student, and because repeated traces can be contributed by the same teams across sessions.
The main limitations are intact-group assignment, potential diffusion between sections, protocol-based measurement that captures traces rather than full interaction, and preliminary single-rater, non-blinded scoring. Small and uneven session-level cells limit interpretation to descriptive pilot evidence and prevent inferential testing.
Opposing-viewpoint structure may introduce a false-dichotomy risk if participants interpret analytic positions as the only legitimate options. This risk was mitigated by framing positions as heuristic poles, encouraging hybrid solutions in the final decision package, and requiring decision maps to document trade-offs and feasibility constraints.

5.3 Future Research and Strengthening Steps

Future iterations should ensure complete artefact capture across all teams and sessions, add independent second-rater scoring and inter-rater reliability, and incorporate delayed post-tests to examine durability. Where feasible, baseline equivalence checks and baseline-controlled analyses should be used. A component analysis could isolate which elements drive incremental gains, such as role-play, timed checkpoints, information updates, message mapping, or CAP-structured public statements. The complete protocol corpus should also use stored fidelity checklists and scoring audit notes to strengthen internal validity.

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Cross-country Analysis of Women's Participation in the Labor Force and Political Representation in Middle East Countries

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Abstract

This article offers an interdisciplinary review of women's constraints and opportunities in the Middle East and North Africa (MENA) using a quantitative cross-country analysis, while it implements econometric models to measure the constraints on female participation in the labor force and parliament presentation. Though there is a vast amount of literature on women's rights at individual country level, the literature lacks a cross-country analysis in the MENA region, particularly a quantitative analysis. This paper fills the gap in literature by using a cross-country analysis of 12 countries in the MENA region to find out the drivers of women's participation in the labor force, and political representation. We test three hypotheses; first what are the factors that have shaped women's participation in the labor force and what is the role of corruption in participation. Second, what are the factors that contribute to female political representation in the parliaments. Third, we test the hypothesis whether women's participation in the labor force and political representation has improved Post- Arab Spring.

JEL Classification: I24, J16, K38**,** Z10

Keywords: *Women's empowerment, Arab spring, gender equality, corruption, patriarchal culture, glass ceilings.*

1. Introduction

Women have had limited access to economy and polity in the Middle East and North Africa (MENA) for decencies. Even in countries with more modern legislations and institutions, due to traditions, customs, and patriarchal culture have observed limited ability to participate in economic activities and political decision-making. The combination of patriarchal attitudes and legal structures have placed women in a highly disadvantageous position in the social order (Kazemi, 2000).

Even if women's rights have been achieved in secularized environments, from a historical point of view, there is no connection between secularization and the promotion of women's rights, nor between secularization and the promotion of equal rights. The Arab Spring helped enormously to aiding democratization (in Tunisia) and heightened many areas of inequalities that has created a global Islamic feminism, in geo-political spere.

Women in MENA are doing worse in terms of political, economic, socio-economic indicators than any other parts of the world, even compared to developing countries (Felder & Vuollo, 2008). Indeed, gender gaps in the region has been exacerbated post-Arab spring despite all efforts of civil societies and legal reforms. The gender gaps have increased in the past decade due to political instability, inter-state wars, domestic conflicts, and civil wars. Some states in the region have restricted access to education for women including Afghanistan, Iraq and Pakistan due to traditional roles that women should play at home. Those states experiencing conflict and high numbers of refugees, for example Lebanon and Syria have limited education possibility due to the economic climate, stereotypes, and beliefs against women empowerment.

The Middle East and Arab region have made the slowest progress across several indicators compared to the rest of the world. The female labor force participation in the MENA region is the lowest in the world and has remined so for several decades (Felder & Vuollo, 2008). This paradox has been explained by discriminatory gender norms, patriarchal culture, and lack of constitutional support, among other factors. The economic participation of women in Arab states is 33.3 percent compared to 55.6 percent in the world. In addition, women only own 17 percent of entrepreneur (Felder & Vuollo, 2008). This data reflects the depth and severity of women's disadvantage in labor force in Arab states.

The poor performance in the MENA region can be attributed to high level of violence against women, discriminatory regulations, and lack of well-designed constitutions and legislations that endanger women's empowerment. But more importantly, one can refer to discriminatory traditions, customs, cultures, and taboos that have been conceptualized in brains of men and women for decades.

The rest of the paper is structured as follows. Section 2. presents the literature review on women's empowerment and its development in different aspects including labor force participation and political representation across different countries in MENA region. Section 3. discusses theoretical framework. Section 4. elaborates indicators, data and methodology used in this study. Section 5. analyzes the estimated econometric results of the cross-country analysis with panel data. Section 6. concludes and provides policy recommendations.

2. Literature Review

One of the important gaps in the literature in the MENA region is lack of research on women's participation in labor force and polity. Research suggests that women in several Middle East countries remain disadvantaged in employment and the society, in general (Seyd & Ali, 2019). To fill the gap in the literature, we first briefly review the situation of women's social status and their participation in labor force and political representation across 12 sample countries including Afghanistan, Algeria, Egypt, Iraq, Jordan, Kuwait, Lebanon, Morocco, Pakistan, Qatar, Saudi Arabia, and Tunisia. We selected these countries from the Greater Middle East, the Maghreb, Arab states and GCC.

i) Women's participation in labor force:

Importance of women to economic development has been highlighted in several studies (Pereira, 2020; Pereira & Bamel, 2021). Though women have advanced in management in Middle East, they have career and development constraints due to the strong gender inequality. More specifically, the number of women entrepreneurs in MENA region is lagging compared to men in many states (Bastin, Metcalfe & Zali, 2019). To address the issue of underrepresentation of women in the labor force, we briefly discuss the barriers women face in several MENA countries.

The gender gap in the labor participation rate is widest in Iraq and smallest in Kuwait and Qatar (EU parliament, 2014). Though in some countries such as Bahrain and Kuwait, families have started to rely more on women's financial support, still the gender gap overwhelmingly spreads throughout the countries in the region.

There is a huge gender gap in economic activities in Egypt, as women participation rate in the labor force does not exceed 20% (Hassan, 2015). Most employed women are in education and health care system. Women are presented in only 31.2% of management positions and there is a huge gap in women's wages with men in different sectors (Hassan, 2015). Lebanon is among the Arab countries that have allowed women to resume functions and responsibilities outside the traditional roles. Though women in Lebanon are increasingly recognized as full-fledged partners in the family economy, decision-making positions in Lebanon continue to be monopolized by men. According to the gender statistics released by the Economic and Social Commission for Western Asia (ESCWA), the number of women enterprise owners in Lebanon is significantly low, with women employers constituting only 1.5 percent of the female workforce (Jamali, Sidani & Safieddine, 2005).

The lack of opportunities for women in Jordan is manifested in low labor force participation of 15%, an unemployment rate of 23%, and a negligible entrepreneurship rate. (Ait Ali Silmane et al., 2020). Despite all the reforms in Jordan, women still have small participation in workplace and only 19% of businesses are co-owned by women. In 2018, only 4% of working women were employer or business owner, compared to 13% for men (Ait Ali Silmane et al., 2020).

Though women constitute 59% of labor force in Kuwait, and occupy 64% of educational system (Meyer, Rizzo, & Ali, 2005), the diminishing level of support for women's rights in Kuwait has been the focus of several studies in Middle East. Indeed, women's trivial presence in economic and political activities is attributed to cultural, institutional, and structural factors. Based on the results of Arab barometer survey, only 12% of respondents agreed that men are better political leaders compared to 30% in Tunisia, and 20% in Lebanon (Thomas, 2019). Female participation rate in labor force is only 23.5% compared to 70.3% for men, which highlights a huge gender gap for that country (Avis, 2017).

Female participation at workplace in Qatar is lower than anywhere else in the world (Al Attiyah & Naser, 2014). Based on a business approach developed by the World Bank, which measure 8 indicators with data that refers to the laws and regulations that are applicable to the business, Qatar stands 29 out of 100 (where 100 represents the highest possible score). The overall Qatar score is much lower than the average of MENA, 51.5 (World Bank, 2021). The most important barriers in Qatar include laws affecting women's pay, pregnancy and work conditions and gender differences in inheritance. However, Qatari women are beginning to attain higher level of education than men.

Only 15% of Saudi Arabia is composed of female work force (Alharbi, 2015). Combination of the economic need for women's investment in the private sector and participation in the workforce, and the

international political pressures for improving women's rights, as well as women's everyday solidarity practices have led to some advancements in women's rights toward equality, but still, there is a long way ahead of the country (Alkhaled, 2021).
Tunisia started early in its reforms and with a better health and education system and succeeded to create a more productive labor force compared to other states in MENA. Despite all reforms, Tunisian women still face several economic and social barriers, related to patriarchal attitudes that prevents them from accessing positions in many economic and political areas. Women represented only 37% of employees in public service in 2016, and 46% of the total workforce. Unemployment rate after the Jasmine revolution has been rising substantially; while unemployment for men stands at 14-15%, unemployment for women is almost twice as men as high as 26-28% (Voorhoeve, 2015).
In sum, it is estimated that MENA region loses USD 575 billion due to current gender-based discrimination in the labor force (World Bank, 2018). Unfortunately, the norms, traditions, and patriarchal culture have contributed to misperception of women about their rights. For instance, over 80% of Jordanians believe that when jobs are scarce, men should have higher rights, and over 70% believe that men make better business decisions than women. (Ait Ali Silmane, 2020).

(ii) Women's rights in political representation:
Women are underrepresented in decision making across the MENA region. For instance, in Egypt, the Supreme Council of Armed Forces (SCAF) appointed an all-male committee to draft constitutional principles for Referendum in March 2011. In addition, no women were appointed in the post 2011 cabinet and no women has ever become a governor (Hassan, 2015).
Iraq witnessed radical changes to its political system post 2003. These changes occurred after many wars, sanctions, and external occupation until it became one of the failed states. Despite introducing new articles in Transitional Administration Law (TAL) in 2004 to protect women and minorities, women have been absent from the front line of the political life. When national assembly was formed in 2004 only 20% of members were women. The share of women in Parliament between 2006 and 2021 has been above 25%. However, these numbers do not represent the real participation and voice of women in leadership and process of building state during the transition (Alwan, Qati, & Ali, 2021).
The amendment of the election law in 2005 opened the doors for women in Kuwait to vote and run for office and participate in parliamentary elections. In 2009 women succeeded to gain 8% of the seats in the election of the parliament. However, the rate decreased to 6% in 2012. And the Parliament did not have a single female candidate in 2013 (Shalaby, 2015). Since 2010 Lebanon has observed a consistent decline in its relative gender gap score, particularly in political empowerment. Only 3.1% of parliamentary seats are held by women in Lebanon (Avis, 2017).
Tunisia has been known for its modern legislations on women's rights. Tunisian females represent 60% of university students in different levels, but are underrepresented in decision-making and political positions (Ouanada, 2020). Gender based discrimination still exists in Tunisia, creating a glass ceiling that has limited women's access to high management and political positions.
Though there have been some reforms in advancing women's role in leadership and political roles in the region, there are still institutional and cultural barriers embedded in decision making and political participation in several MENA countries.

3. Theoretical Framework

As elaborately pointed out by several scholars including: Danon & Collins (2021); Seyed & Metcalfe (2017); Zulfiqar (2019), and Pereira et al. (2020) women in MENA have been faced with the key following challenges:

1. Women do not participate in the labor force to the same degree of women in other parts of the world even in developing countries (Danon & Collins 2021).
2. Women are poorly presented in legislative bodies, such as parliaments, compared to global averages (Avis 2017; Danon & Collins 2021).
3. It is perceived that women's participation in the labor force and political representation have deteriorated in several MENA countries since Jasmine revolution.

This study uses a quantitative approach covering 12 countries in the region to test three hypotheses: (i) does education matters to participation in the labor force and political presentation (ii) Does corruption index matter for female participation in the labor force and political presentation (iii) has Arab spring contributed or deteriorated the degree of women's participation in the labor force and representation in the political system.

4. Data and Methodology

4.1 Data

We use the data from the world development indicators of the World Bank website and from Congressional Budget Office to compare the situation of women among MENA countries. Table-1 indicates the highest female labor force participation is found in Qatar and Kuwait, while Iraq and Pakistan have had the lowest participation rate due to severe constraints on women's career development. We also use an index which reflects the misperception of women about their rights, women who believe men are justified in beating their wife. This index is highest for Afghanistan, Iraq, and Pakistan compared to other countries, outlining the dramatic patriarch culture, male dominancy, and lack of judicial protection for women, which has been exacerbated in post conflict states.

Table 1. Comparative analysis of women participation indicators in the Middle East (2021)

Country	Literacy rate among women (%)*	Labor force participation female (%)	Women married at age of 15 relative to 15-24 years old females	Women who believe men are justified in beating wife
Afghanistan	-	21.36	4.2%	80.2
Algeria	75.3	-	-	-
Egypt	65.5	18.49	2%	35.7
Iraq	79.9	11.41	7.2	51.2
Jordan	97.8	-	-	-
Kuwait	94.9	50.19	-	-
Lebanon	93.3	22.9	1.4%	9.7
Morocco	64.6	-	-	-
Pakistan	65.18	21.65	3.6%	41.1
Qatar	94.7	56.92	0%	6.6
Saudi Arabia	92.7	21.95	-	-
Tunisia	72.2	25.12	0%	30.3

Source: * Women in Middle East and North Africa: Issues for Congress, retrieved from https://sgp.fas.org/crs/mideast/R46423.pdf
World Bank, World Development Indicators.

Table 2. on gender index and seats held by women in parliament indicates that Kuwait, Afghanistan, and Pakistan have had the lowest share of women's participation in the parliament; however, Egypt, Iraq, and Tunisia have had the highest shares, mainly due to legislative reforms and more democratic societies run by relatively liberal regulations compared to other states.

Table 2. Comparative analysis of gender inequality in Middle East Countries (2019)

Country	Social Institution and Gender Index (1)	Constitutional provisions (2)	Share of seats held by women in parliaments (2)	Absence of Legal discrimination score (lower=more discrimination) (3)
Afghanistan	52.8%	NO	2.3%	38.1
Algeria	-	-	7.5%	-
Egypt	-	Yes	22.9%	45
Iraq	53.7%	Yes	26.4%	45
Jordan	57.3%	-	11.8%	-
Kuwait	-	No	1.5%	29
Lebanon	56.2%	No	4.7%	53
Morocco	50.8%	-	20.2%	-
Pakistan	58.7%	No	4.5%	55.6
Qatar	-	Yes	9.8%	29
Saudi Arabia	-	No	19.9%	80
Tunisia	47.6	Yes	26.3%	68

1.Source: UNICEF.org retrieved from https://data.unicef.org/resources/data_explorer/unicef_f/?ag=UNICEF&df=GENDER&ver=1.0&dq=.GN_IDX....&startPeriod=2009&endPeriod=2019
2. Women in Middle East and North Africa: Issues for Congress, retrieved from https://sgp.fas.org/crs/mideast/R46423.pdf
3. Georgetown Institute for Women, Peace, and Security, (GIWPS) retrieved from: https://giwps.georgetown.edu/wp-content/uploads/2021/10/WPS-Index-2021-Summary.pdf

To find out the relationship between women's participation in labor force with independent variables, we use panel data for the period of 2005-2023. The data on women's labor force participation, tertiary education, GDP growth, Budget Deficit, Per-capita loan and financial development and share of seats held by women in parliaments are retrieved from the World Bank Indicators of the World Bank website, and data on corruption index is retrieved from International Transparency.

4.2 Methodology

We investigate the factors that contribute to low participation in labor force and underrepresentation in parliaments. The effects of advanced education on labor force participation have been emphasized by several scholars including (Dandan & Pereria Marques, 2017; Barsoum, 2018; Aziz Khan, 2019). Moreover, the correlation between women at work and corruption has been the focus of several studies including Dollar, Fisman, & Gatti (2001) who find the greater representation of women in parliament, the lower the level of corruption. Global Organization of Parliamentarians Against Corruption (GOPAC) investigate the effects of gender equality on corruption and find that an increase in the number of females in the Parliament tend to reduce official corruption. Samimi et al. (2013) use panel data for the period 2003-2010 for 27 selected Islamic states and find that with an increase in the rate of women's participation in labor force corruption has decreased dramatically.
Corruption is generally seen as a harmful element that contributes to business ethics glass ceiling. The glass ceiling develops because in reacting to corruption, small and medium-sized enterprises (SMEs) and small family firms remain opaque and unable to access financing outside the family network or traditional bank loans.
Our study is different from the previous studies, and it follows Bishara (2011) in the sense that causality runs from corruption to gender inequality because the corrupted governments leave fewer resources for private sector, through crowding out effect. As such, less space is left for women to participate in the labor market. We test the hypothesis that corruption has affected women's participation in labor force and representation in parliaments.
We also use a dummy variable for Arab spring post 2011 to find out whether there has been any improvement in women's right for access to labor market and seats held in the parliaments post-Arab spring.
We estimate equations 1. and 2. with panel data for the period of 2005-2023 for the 12 above-mentioned countries.

$$FLP = a_0 + a_1 \sum_{i=1}^{n} \sum_{j=1}^{k} Edu + a_2 \sum_{i=1}^{n} \sum_{j=1}^{k} Corrup + a_3 \sum_{i=1}^{n} \sum_{j=1}^{k} X_{ij} \qquad \text{Equation 1.}$$

$$PPR = b_0 + b_1 \sum_{i=1}^{n} \sum_{j=1}^{k} Edu + b_2 \sum_{i=1}^{n} \sum_{j=1}^{k} Corrup + b_3 \sum_{i=1}^{n} \sum_{j=1}^{k} X_{ij} \qquad \text{Equation 2.}$$

List of Variables
FLP represents female participation in labor force, *PPR* represents political presentation measured by seats held by women in the parliament, *Edu* refers to tertiary education at university level, *Corrup* is index of corruption measured by Corruption Index of Transparency International, and matrix *X* represents control variables or fixed effects across different countries, including GDP growth (GDPG), Budget deficit (BD), access to bank loans measured by per-capita loan (PCL), and level of financial development (FD) measured by private sector credit to GDP. We use two dummy variables; the first dummy (D1) equals 1 for the post Jasmine revolution (Arab spring in 2011) and the second dummy (D2) relates to the post war states. Finally, *i* represent the year and *k* represents the country.

5. Estimated Results

5.1 Estimated Results for Women Participation in the Labor Force

Table 3. indicates that all independent variables together can explain more than 85% of changes in women participation in the labor force. The coefficient on education is statistically significant at 5% and represents the elasticity of women's participation in labor force to tertiary education (since model is in logarithm form). This elasticity is estimated around 0.34 and indicates that one percent increase in the number of people in tertiary education increases the possibility of female participation in the labor force by 0.34 percent. Expectedly, the coefficient on corruption is negative and statistically significant, and indicates that one percent increase in the index of corruption reduces the possibility of women participation in the labor force by 0.12 percent. In other words, consistent with theory and indicated by some scholars including (Bishara, 2011) in a more corrupted society there is less chance for women to participate in the labor force. This result highlights the importance of reforms against corruption in the Middle East for women's participation in the labor market.

The coefficient on the dummy variable for Jasmine revolution (D1) is negative and statistically significant, indicating that the Arab Spring has exacerbated women's participation in the labor force. As emphasized by some scholars including Chamlou & Karshenas (2016); and (Battaloglu & Fassin, 2017), the post Arab Spring states are more conservative and have had serious threats that undermines the gains women had achieved over the past 20-30 years on economic and social fronts. Finally, the coefficient for the second dummy variable (D2) is negative and statistically significant, highlighting that post war states have had lower participation of women in the labor force.

Interestingly, the coefficients on GDP growth, private credit, and financial development as control variables are not statistically significant, indicating that women's participation in the labor force in MENA has not been shaped by business cycles and macroeconomic fundamentals, as there are several barriers to their career development, which emanate from legislations, customs, and patriarchal culture rather than macroeconomic environment.

Table 3. Women's education and corruption effects on women's labor force participation

Variable	Coefficient
Education	0.34 (0.02)
Corruption	-0.12 (0.03)
BD	0.14 (0.05)
D1	-0.17 (0.04)
D2	-0.13 (0.03)
GDPG	0.05 (0.04)
PCL	0.04 (0.07)
FD	0.12 (0.13)
R-squared	0.85
Adjusted R-squared	0.82
F-statistics	26.35
Durbin Watson	1.89

Source: Authors' estimation; numbers in parenthesis are standard deviations.

5.2 Estimated Results for Women Representation in Parliamentary Seats

The relationship between corruption and political presentation has been the focus of several scholars including Bishara (2011); Moghadam, (2015); Dandan & Periera Marques, (2017). In addition, education, and knowledge sharing promote human capital as emphasized by several scholars including Budhwar, et al. (2019); Preiera (2020); Budhwar et al. (2020); Bamel, Pereira, & Cappiello (2021); Pereira & Bamel (2021); Pereira & Mohiya (2021); Bamel, Pereira, Giudice, & Temouri (2022). Given

the importance of education and corruption in affecting political representation we use these two variables besides the dummy variables as independent variables in the regression models. Furthermore, we control macroeconomic conditions and business cycles by implementing control variables such as GDP growth, private sector credit, and degree of financial development.

The estimated results indicate that all independent variables together explain more than 87% of changes in women's participation in the parliaments. The elasticity of women's seats held in the parliaments to education is estimated 0.12, which indicates one percent increase in the number of females in tertiary education will increase women's participation in the parliament by 0.12 percent. Expectedly, the coefficient on the corruption is negative and statistically significant and equal to 0.17, which indicates one percent increase in the corruption index reduces the number of seats held by women in the Parliament by 0.17. The result is alarming and highlights the importance of anti-corruption reforms in the region for the empowerment of women and their participation in the parliament and political decision-making.

Again, the coefficient on the dummy variable for the Arab spring is negative and statistically significant, indicating that Arab Spring has adversely impacted women's participation in political representation and decision making. Indeed, though a few countries have been able to carry out reforms to improve women participation post Arab Spring, the net effect for majority of countries has been negative. Our result is consistent with the finding of Sinha (2012), and Battaloglu & Fassin (2017) who find Arab-Spring has deteriorated women's situation and participation in political activities. Finally, the dummy variable on the war states (D2) is negative and statistically significant, indicating that women in the post war states such as Afghanistan, Algeria, and Iraq have experienced lower participation in the parliament. And the coefficient on the dummy for war states is almost twice as the coefficient on Jasmine revolution. Indeed, the war states have experienced a worse situation for participation of women in the parliament and decision-making.

In addition, the post-Arab Spring political events indicate pressures on Middle East countries to democratize has been replaced by security cooperation and anti-terrorism measures as the top priority (Battaloglu & Fassin, 2017). This replacement has had severe negative consequences for women's participation in economic and political activities, undermining women's empowerment and promoting radicalism.

Finally, the coefficients on GDP growth, private sector credit and financial development are not statistically significant, indicating that women's participation in the parliaments have not been shaped by orthodox macroeconomic fundamentals. On the contrary, women participation in the parliament has been impacted by the level of corruption, jasmine revolution and post-war states.

Table 4. Women's education and corruption effects on female representation Parliament in MENA

Variable	Coefficient
Education	0.12 (0.03)
Corruption	-0.17 (0.05)
D1	-0.03 (0.01)
D2	-0.07 (0.03)
GDPG	0.04 (0.07)
PCL	0.01 (0.05)
FD	0.02 (0.03)
R-squared	0.87
Adjusted R-squared	0.84
F-statistics	57.61
Durbin Watson	1.94

Source: Authors' estimation; numbers in parenthesis are standard errors.

6. Concluding Remarks

The whole MENA region faces severe challenges and lags economic and political participation compared to the rest of world even in developing countries. However, there are huge differences among the countries in the region. Though some countries have been able to carry out major legislative reforms, others have been left behind and there is a huge gap among these countries regarding women's participation in the labor force and political presentations. We contributed to the literature by using quantitative cross-country analysis and implementing econometric models with panel data to test the hypothesis of whether education and corruption has affected women's participation in the labor force and polity. We found that corruption plays a detrimental role in women's participation both in labor force and political representation. Therefore, anti-corruption reforms should be at the forefront in the region, not only by domestic governments, but also by the international donors and governments who provide foreign aid to the MENA region. Conditionality of foreign aids to anti-corruption measures is an instrument that can help women in the MENA region to achieve greater gender equality and empowerment.

We also used a dummy variable for Post-Arab Spring to find out whether women's participation in economic and political representation has deteriorated post Arab spring. Expectedly, and in accordance with several scholars we found that Jasmine revolution has had a negative impact on women participation in the labor force and polity. In addition, we found that, while macroeconomic fundamentals do not matter for women's participation, being in a post war state has limited participating in labor force and polity.

Challenges for improving the conditions of women in the Middle East include changing legislations with emphasis on women's rights, access to free education, constitutional reforms, and more importantly, fighting against corruption as a widespread phenomenon in the region. The old patriarchal culture, male supremacy, female misperception of their image, and internalizing external barriers are among the main impediments that hold back societies from moving toward a more democratic state with equal gender rights. Thus, there is a fundamental need for cultural reforms that fights against corruption, patriarchal culture, taboos, and traditions; without such reforms, moving toward a more democratic society, which respects the empowerment of women with equal gender rights under current dynamic interconnected barriers from culture, regulations, and governments seems inaccessible, if not impossible.

Avenues for Further Research

One of the areas that this research study can be developed in the future is to expand the sample to include more countries particularly north African countries that suffer from civil wars, domestic conflicts, and enormous level of government corruption. Another area for improvement is to use more control variables to capture macroeconomic differences among countries. For instance, interest rate, trade openness, and financial integration into global economy can crystallize the cross-countries fundamental differences more significantly. Another issue that can be addressed in the future is using different econometric techniques such as Two Stage Least Squared (2SLS) and Vector Auto Regression (VAR) model to control for missing variables and misspecification.

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European Funding Opportunities in Higher Education: The Role of Erasmus+ in Fostering Institutional Growth and International Cooperation in Higher Education

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Abstract

This paper presents a comprehensive overview of the Erasmus+ Programme as a strategic funding mechanism for higher education institutions (HEIs) and other organisations operating in the field of education and training. Drawing on Pixel's extensive experience as project coordinator, the paper examines the programme's key action lines most relevant to higher education: Cooperation Partnerships (KA2) and Capacity Building projects. The paper outlines the four horizontal priorities that cut across all sectors of the programme (Inclusion and Diversity, Digital Transformation, Environmental Sustainability, and Participation and Active Citizenship) and discusses how these priorities shape the design and evaluation of project proposals. A selection of nine approved Cooperation Partnership projects and six Capacity Building projects coordinated by Pixel is presented to illustrate the range of eligible activities, partnership configurations, and deliverables that characterise successful applications. These examples span topics from computational thinking in STEM teacher education, to the integration of artificial intelligence in language learning, to the promotion of intercultural dialogue and emotional intelligence in secondary schools. The paper then provides practical guidance on the formulation of competitive project ideas, emphasising the importance of needs analysis, innovation with respect to the state of the art, consistency between objectives, activities and results, and clear identification of target groups. Special attention is devoted to the Capacity Building strand, which funds cooperation between European HEIs and partner-country institutions across regions including Sub-Saharan Africa, the Middle East, Latin America, and the Western Balkans. The paper concludes by positioning the Erasmus+ Programme not merely as a funding source, but as a driver of systemic institutional change and international networking, and by offering concrete recommendations for institutions approaching the programme for the first time.

Keywords: *Erasmus+, higher education, cooperation partnerships, capacity building, European funding, internationalisation*

1. Introduction

The Erasmus+ Programme is the European Union's flagship initiative for education, training, youth, and sport. With a budget of approximately 26.2 billion euros for the 2021–2027 programming period which nearly double that of its predecessor, it represents the most significant multilateral investment in knowledge and human capital in European history. For higher education institutions, the programme opens a wide spectrum of opportunities that extend well beyond student and staff mobility: through its cooperation and capacity building strands, Erasmus+ funds the joint development of curricula, teaching methodologies, assessment tools, training packages, and policy recommendations, in partnership with institutions across Europe and the world.

This paper aims to provide practitioners such as researchers, lecturers, academic coordinators, and institutional leaders, with a structured understanding of how the programme works, what kinds of projects it funds, and how to translate institutional priorities into competitive proposals. The analysis draws on Pixel's direct experience managing Erasmus+ projects since the earliest programme generations, and on a curated set of recently approved projects that exemplify best practice across different sectors and geographic contexts.

2. The Erasmus+ Programme: Structure and Priorities

The current Erasmus+ Programme is structured around three Key Actions. Key Action 1 (KA1) supports learning mobility for individuals. Key Action 2 (KA2), the primary focus of this paper, funds Cooperation Partnerships and Capacity Building projects. Key Action 3 supports the development of policy and cooperation at the systems level.

Across all actions and sectors, four horizontal priorities are mainstreamed: Inclusion and Diversity, Digital Transformation, Environmental Sustainability, and Participation and Active Citizenship. These priorities are not optional thematic labels: they are embedded in the evaluation criteria and applicants are expected to demonstrate how their project contributes meaningfully to at least one of them.
The programme is open to a wide range of eligible organisations: higher education institutions, schools, vocational education and training (VET) providers, adult education centres, and youth organisations. Eligible countries include the 27 EU member states, EEA countries (Iceland, Liechtenstein, Norway), and a number of candidate countries. For Capacity Building projects, partnerships extend to third "partner" countries across the globe.

3. Cooperation Partnerships in Higher Education (KA2)

Cooperation Partnerships fund transnational projects that develop, transfer, and implement innovative practices in education and training. In the higher education sector, the programme specifically encourages proposals that stimulate innovative teaching and learning practices, develop STEM/STEAM curricula, support digital and green capabilities of HEIs, and promote innovation and entrepreneurship.
Projects receive grants of up to 400,000 euros and run for two to three years. The expected deliverables are concrete and transferable: joint curricula, training packages, teaching sources, assessment tools, guidelines, toolkits, case studies, and policy recommendations. The emphasis on tangible intellectual outputs distinguishes Erasmus+ Cooperation Partnerships from more general research grants and ensures that funded activities generate resources that outlast the project itself.

3.1 Examples of Approved Cooperation Partnerships

To illustrate the breadth of eligible activities, the following projects, which are currently coordinated by Pixel, have been selected as representative examples.
The Co-Think project (https://cothink.pixel-online.org/) targets the development of future STEM teachers' skills in computational thinking. Its main outputs include a framework for computational thinking teaching, a microcredentials-based course, and a suite of lesson plans and student assignments.
The DAI project (https://dai-project.eu/) addresses the integration of artificial intelligence in the teaching of Italian as a foreign language. Deliverables include a teacher training course on AI in language education, a repository of AI-based resources featuring a personalised chatbot, and a learner corpus derived from student interactions.
The EME4EU project (https://eme4eu.pixel-online.org/) promotes English-Medium Education (EME) as a lever for university internationalisation, producing a collection of good practices, decision-maker guidelines, and a teacher training package.
The BRIDGE project (https://bridge.pixel-online.org/) centres on intercultural dialogue in higher education, delivering a digital museum on integration, micro-credential training courses, and governance guidelines for HEIs.
The POEMS project (https://poems.pixel-online.org/) focuses on emotional intelligence in secondary education, producing self-assessment tools, training materials, and a research publication.
The READY project (https://readyreading.eu/) equips primary school teachers with tools to identify and address literacy disadvantages, including game-based intervention toolkits.
These examples demonstrate that successful Cooperation Partnerships share several structural features: a clearly identified gap in practice or policy, a transnational consortium with complementary expertise, a set of outputs designed for reuse beyond the project, and a robust dissemination and sustainability strategy.

4. Capacity Building in Higher Education

The Capacity Building strand of Erasmus+ (KA2 HED) is designed to foster structural cooperation and reform in higher education in third "partner" countries. Unlike Cooperation Partnerships, which operate among Programme countries, Capacity Building projects explicitly require partnerships between HEIs in EU member states and HEIs in partner regions.
The expected impact on partner-country institutions is wide-ranging: modernising HEIs, improving the quality and accessibility of higher education, promoting innovation and better governance, increasing digital competence for students and staff, strengthening links with the private sector, aligning academic provision with labour market needs, and enhancing employability and entrepreneurship.

4.1 Examples of Approved Capacity Building Projects

Pixel's Capacity Building portfolio spans multiple partner regions. In South Africa, the ProTELDE project (https://digitalskills.uj.ac.za/) equips HEI and TVET lecturers with skills to identify, use, and create digital teaching sources for business and economics education. The AFJ project (https://entrepreneurialskills.uj.ac.za/) targets the employability and entrepreneurial skills of graduates and the pedagogical capacity of educators in business disciplines.
The Ted-SOEP project (https://www.tedsoep.org/), also based in South Africa, promotes self-directed learning methodologies and the integration of open educational resources in STEM teacher education.
In Costa Rica, the EthicalAI project (https://www.ethicalaiucr.info/) establishes a regulatory framework for the ethical use of AI in university settings and develops training resources for higher education lecturers.
In the Palestinian context, the CARE project (https://care.edu.ps/) strengthens HEIs' capacity to deliver high-quality, practice-based Early Childhood Education and Care (ECEC) training, modernising curricula in line with EU standards and promoting EU-Palestinian institutional cooperation. These examples reflect the global reach of the Capacity Building strand and its potential to generate lasting structural change in partner-country higher education systems.

5. Formulating a Competitive Project Proposal

Irrespective of action line or sector, competitive Erasmus+ proposals are built on a rigorous process of project idea formulation. Based on Pixel's experience evaluating and coordinating applications, five stages are critical.
First, applicants must conduct a thorough analysis of programme objectives and priorities, ensuring that the proposed project is demonstrably consistent with the guidelines published in the relevant Call for Proposals and the Erasmus+ Programme Guide. The European Commission's Funding and Tenders Portal (https://ec.europa.eu/info/funding-tenders/opportunities/portal/) is the authoritative reference for this stage.
Second, a state-of-the-art analysis is essential. Project proposals should demonstrate awareness of previous initiatives, lessons learnt, and existing results in the field. The Projects and Results section of the Funding and Tenders Portal provides searchable access to previously funded projects and should be consulted systematically.
Third, target groups must be identified precisely. This entails defining the profile of intended beneficiaries, conducting or citing a robust needs analysis, and articulating the motivations that make these groups receptive to the proposed intervention. Erasmus+ explicitly values the bottom-up approach: projects should be driven by the real and documented needs of practitioners and learners, not by the interests of applicant institutions alone.
Fourth, project objectives must be consistent with identified needs, realistic within the timeframe and budget, and clearly outlined in measurable terms. The logical chain from needs to objectives, activities, and results must be internally coherent and transparent.
Fifth, activities must be detailed, sequenced, and directly traceable to the stated objectives. The definition of results and deliverables must reference quantifiable indicators and be fully consistent with the planned activities and partnership resources.

6. Conclusions

The Erasmus+ Programme represents a unique opportunity for higher education institutions to access substantial European funding, develop innovative educational resources, and build durable international partnerships. Its value, however, extends beyond financial support: participation in Erasmus+ projects positions institutions as active contributors to the European Education Area and generates systemic benefits in terms of staff development, institutional visibility, and curriculum innovation.
For institutions approaching the programme for the first time, the advice is practical: begin by identifying an authentic institutional need that aligns with programme priorities, invest in a thorough state-of-the-art analysis, build a partnership with genuine complementarity across national contexts, and design outputs that will be used and sustained beyond the project duration. For experienced applicants, the challenge is to push beyond incremental improvements and propose genuinely innovative approaches that reflect the evolving priorities of the European educational landscape — including the ethical integration of artificial intelligence, the transition to sustainable educational practices, and the deepening of inclusion agendas.

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Against the Robotization of Education

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Abstract

The Action Network BC—an amalgam of organizations and initiatives focused on organizing, advocacy, and community engagement in British Columbia, Canada-- recently sent out a petition for signatures of educators in support of a request that the provincial government put a "pause on generative AI in BC schools". Of course, the proverbial ship has sailed in terms of AI and a "pause" is daunting, if not impossible. The petition demonstrates the compelling concern with "AI dependency in young people" and the deleteriousness of this dependency in terms of the mental health of youth. This action arises from a deep anxiety among educators and education policymakers with the rise of AI and with the dramatic shift in educational practices, policies, and culture. The transformations wrought by AI are not unprecedented. Such decisive and profound social transformations have been in abundant evidence throughout the entire history of communication technological innovation and advance, and especially in the emergence of digital technologies in educational contexts. Almost 20 years ago, Nicholas Carr asked the provocative question, "Is Google Making Us Stupid?", an article in the Atlantic that was the foundation for his book, The Shallows: What the Internet is Doing to Our Brains. (Carr, 2020) [1] Carr's concerns with the internet were focussed less on the unprecedented availability and ubiquity of a digital avalanche and velocity of information, and more with how the very communicative form of the internet molds our understandings of self and society, and the priorities and assumptions we make about the world around us. The consequences have been profound and both cognitive and cultural in nature. Following advances in neuroscientific research, Carr offers an account of a particular neuroplasticity—how the brain changes with experience; that is, how our use of communication technologies alters our neuropathways to the extent that digital or screen addiction became an issue to be reckoned with. There is of course, a long history of concern and critical engagement around digital "addiction", or the compulsive use of digital devices and an excessive amount of screen time. This history for many critical observers culminated in the March 2026 ruling that Meta and YouTube were negligent and that these platforms were purposefully developed and designed to be addictive, thereby causing harm to the mental health of youthful users. The jury rejected Mark Zuckerberg's claim that Meta does not design apps to maximize screen time. This was a "rare verdict holding Silicon Valley accountable for its role in fueling a youth mental health crisis." (Allyn, 2026) [2] Compounding the complexity to this issue is AI-dependency and the cognitive offloading it affords that results in diminishing capacities of analytical acuity, critical and independent thinking, problem-solving, and more. This paper explores the complexities and contestations, the arguments and the fears around the "robotization of education".

Keywords: *AI dependency; cognitive surrender; digital addiction*

Introduction

While "disruption" has characterized the velocity and magnitude of change in higher learning's digital age, the word is rather less than adequate descriptor for the ongoing elaboration of AI. Indeed, AI has well and truly presented higher education with an existential moment in which centuries old forms of assessment are increasingly exhausted. An idealized notion of the traditional university has certainly been resilient rooted as it is in 11th to 13th century medieval approaches to education which include the lecture as the primary transmissive model and established forms of assessment that have been highly resistant to change. Now AI demands that higher learning requires nimbleness and a commitment to a formidable project of educational revision; and such continuous revision is the norm, now and in the future.

Stephen Marche has provocatively argued that AI has signaled the death of the traditional form of the long essay, the bedrock of evaluation in the arts and humanities. (Marche, 2022) [1] Indeed, for undergraduate students, AI rather unproblematically circumnavigates the demands and conventions of the university essay by bypassing the deep dive of research engagement and the crafting of an essay built on that research. AI serves up a text on any theme with immediacy and polish (robotic as the prose

may be). Dilkes goes further by identifying the need to challenge and change the very purpose of education; that is, if we continue to emphasize the objective of passing over learning, then student use, or misuse as it were of generative AI technologies "is nothing more than a rational action by a rational agent" [Diles, 2026) [2].
This question needs to be posed because AI has re-introduced us to an undeniably academic preoccupation--academic integrity. Indeed, plagiarism and other forms of academic dishonesty have long been a cause for hand-wringing distress among every teaching professional in higher learning; and this was a problem with the introduction of Chat GPT and other platforms of generative AI. An initial and clearly persistent institutional response focussed on containment of the technology over integration of the technology, and an attempt to contain the uncontainable is inevitably a pathway to failure.
This paper addresses the currents and controversies in what I call the "robotization of education". The purpose here is not to embrace or reject AI, both unviable directions and intentions. Educators are well-aware of the range and diversity of perspectives around AI—from contestation to accommodation, from the critical to the celebratory, from opposition to acquiescence, and more—and none of these perspectives is singular or autonomous. Instead, in the complexities of AI and its evolving relationship to educational policies and frontline pedagogical philosophy and practice, education needs to resist the uncritical accommodation of ongoingly emergent AI technologies. Instead, our educational strategy and vision must be to forge capacities, qualities, resources, and assets in relation to AI that serve and not lead pedagogical invention.

Brain Melt

Almost 20 years ago, Nicholas Carr asked the compelling question, "Is Google Making Us Stupid?". This was the title of his article in the *Atlantic* that formed the foundation for his book, *The Shallows: What the Internet is Doing to our Brains*. (Carr, 2020) Carr's concerns with the internet were focussed less on the unprecedented availability of a digital avalanche and velocity of information and more with how the very communicative form of the internet molds our sense of self and society, and the priorities and assumptions we make about the world. The consequences have been profound and both cognitive and cultural in nature. Following advances in neuroscience research, Carr offers an account of a particular neuroplasticity—how the brain changes with experience; that is, how our use of communication technologies alters our neuropathways to the extent that digital or screen addiction emerged as urgent and critical malaise in contemporary and likely future society.
In recent times there has been a spate of studies that have asked key questions about how we perceive, engage with, and depend on AI. These questions focus on the urgencies and themes of AI's potential impacts, including for examples: "Is AI making us stupid" (Kosmyna et al, 2025) [4] and is AI "reshaping" and diminishing human reasoning" in the process of "cognitive surrender" (Shaw and Nave, 2026) [5]. At issue is the ultimately damaging inclination to abandon critical thinking and to outsource thinking to AI technology. While we have been cognitive offloading for a rather long time—writing to stand in for memory, calculators for computation, GPS for mapping and navigation, search engines for quick answers, and more—cognitive surrender is an entirely different process. As John Nosta contends, (Nosta, 2026) [6] LLMs go well beyond memory and navigation; rather "they can offload the formation of thought itself." He refers to the diminution of the "friction of thought", not an extension of cognition but a replacement for cognition. What this looks like in education is that the technology has "bypassed the very processes that create understanding." Dialogism, the foundational principle of education since Socrates is not even a hint in the unidirectional process of cognitive surrender as the "user" is passive and muted.
AI dependency in the educational context is particularly problematic because it short-circuits rather than strengthens cognitive activation, the "friction of thought" that is foundational to learning. Such technology offers an irresistible prospect for the student predisposed to using it. Instead of the labour-intensive cognitive struggle, students turn to the ready-to-wear solution of the instantly retrievable, fluent, and perfectly adequate AI answer.
Neil Postman once mused on what he called the Faustian bargain of technology: "technology giveth and technology taketh away". This is a useful critical strategy of course that recognizes technological advance always has a cost, and a substantial one at that. The contestations of perspectives ranges from conceptualizing AI as a means, acceleration, and advantage in scientific research and innovation, for instance; and also, as tyrannical and ethically malleable as a technology that is never merely used but in fact as one that shapes society and therefore has massive consequences in the realms of politics and culture, social norms, ethics and morality, education and intelligence. Postman argued that technology is an "ecological" force that is not simply additive but in fact alters the very bases of human perception

and the environments in which we acquire knowledge, seek and find truths, understand and sustain social relations. (Postman, 1992) [7]
Technological advance and elaboration have always been determinative in education and pedagogical practice and priorities, and the accelerated pace of technological change outpaces our abilities to assess it, let alone make policies for it. Metaphorically speaking, the ground is shifting as we stand on it and herein lies the formidable challenge for higher education. As a vast industrial robotization transforms societies around the globe, from culture to business, from industrial strategy to everyday social life, from the operations of government to the operation of domestic space, how do we conceptualize the project, the vision, and the mission of higher education? The dilemma faced is how we revise, but more comprehensively invent teaching and learning around AI that go beyond lists of prohibitions and recognize the imperative of AI literacy and ethicality among our students.

Calls for "Pause"

In March 2023, more than 1000 tech industry leaders, AI researchers, and other AI technology experts signed an open letter that was published by the *Future of Life Institute*. (FLI). (FLI,2023) [8] They called for a six-month pause on the development of AI systems. This push for a moratorium arose from compelling factors of an existential nature. In particular, the letter offered a warning of social, economic, and political disruption, even crisis as AI enabled the acceleration of misinformation and elaborated the long-established threat of automation and the replacement of humans across every sector in society (jobs and the labour force, business and finance, education, governance, to law, and countless other societal institutions).
The advocacy for slowness, or even a moratorium in AI development and application is forcefully resonant in education. In Canada, the Action Network, British Columba—an open-source platform for grassroots advocacy around progressive causes—recently disseminated a petition for signatures of educators to support and mobilize for a "pause" in AI in all provincial K-12 and post-secondary schools. (Action Network BC, 2026) [9] The petition demands that students will not use generative AI in classroom, nor use generative AI for homework. With reference to major studies in the fields of education and psychology, the petition details the "harms" of AI use in schools including harms to learning, relationships and emotional development, and mental health.
This campaign is linked to a global organization, the influential PauseAI which engages in action to oppose the unrestrained adoption of AI, and is a nexus for websites, documentaries, research papers, and many other resources that are critical of AI's accelerated insinuation into and restructuring of societal systems and institutions. PauseAI is part of an expanding and organized intervention that defines the risks and threats posed by AI. Such threats include misinformation, polarization and the threat to democracy; deepfakes and scams; automated biases and discrimination; joblessness and social and economic inequities; isolation, digital addiction and mental health; surveillance and loss of privacy; environmental burden and harm of data centres; and more.
The cause for pause is persuasive and impelling, and calls to action are irrefutably evidence-based and philosophically sound and driven by ethical and moral motivations. The train of AI however, has left the station, to apply a common idiom; but the contestations over AI are motivated by a concern that this does not become a runaway train.

The Robots Are Coming for Our Jobs

The idea of the robotization of society identifies a radical and decisive transformation from industrial automation (itself a profound epochal social transformation) to the broad integration of robotics into society. The ethical risks of robotization are legion in number and clearly are the source of a deep and pervasive anxiety. As our daily interactions with institutions of government, business, education, medicine, law, entertainment, and much more are increasingly interactions with trained bots, the more pointed and vigorous the debates around AI have become.
For our students, even as they use AI as an extraordinarily resourceful academic servant, the complexity of AI compounds an already fraught and contingent world. This is a world beset with rancor; a world in which the young see their futures predetermined, even foreclosed in the incendiary state of the globe; a world in which technological advance creates waves of anxiety; a world in which the financial futures of the young look like a cul-de-sac as AI is transformative and foundational in defining these futures.
As widely reported, during graduation week in the US, "the emissaries of the nation's elite" (Heilweil, 2026) [11] made their appearances as invited commencement speakers at graduation ceremonies on campuses across the country. As Heilweil notes, "The problem this year, however, is that the news of

the day is artificial intelligence, and students just don't want to hear it." It probably wasn't the kind of viral attention she thought she might receive, but on May 8 Gloria Caulfield, a real estate executive and commencement speaker at the University of Central Florida was resoundingly booed by students as she offered a celebratory and effusively optimistic declaration of the beneficence of AI and its importance as the "next industrial revolution". In a similar vein, in May, Nashville-based Big Machine Records CEO Scott Borchetta (famous as the "discoverer" of Taylor Swift) gave a commencement speech to graduates at Middle Tennessee State University and was booed as he spoke glowingly of AI with a particular emphasis on the fact that AI was "rewriting production" at that very moment. In response he exhorted the students to "deal with it". And former Google CEO Eric Schmidt was booed by students at the University of Arizona's Graduation ceremonies at the mention of AI's impact on jobs and the future of graduates who need to adapt to a technology that will "shape the world." The question he asked is whether the students will "shape artificial intelligence". His question was not well-received, but he did utter a truth when he noted, "There is a fear in your generation".

It is noteworthy that co-founder of Apple, Steve Wosniak was cheered in his commencement address at Grand Valley State University in Michigan when he assured his audience, "You all have AI—actual intelligence." He assiduously avoided the inflated rhetoric of triumphalism that characterizes most of the discourse around AI as he encouraged students to use their innate creativity and curiosity, an emphasis on human traits, on creation over copying, on submitting to algorithms to define their lives and ultimate careers.

If the AI bots are coming, the members of Gen Z appear to not be joining the pep rally unreservedly. Amongst youth, there is prevailing skepticism around AI's effects and outcomes and anxiety about AI's negative impacts, especially automation and diminishing job prospects. The disgruntled students were understandably unreceptive to AI boosterism. Some AI proponents admonished students to get on board with a vision of a future defined, driven, and dominated by AI and automation when what those students **are feeling is unsettlement, anxiety, and anger.**

Conclusion: A Seismically Shifting Ground

Undeniably, young minds are fearful of and challenged by a future of AI ubiquity and its determinative power. Numerous studies and critical analyses have established this unsettled relationship between AI and the young (Brynjolfsson, et al., 2025) [12]; Williams, 2026[13]; Sonnenfeld, et al., 2026) [14]; Gallup, Walton Family Foundation, GSV, 2026) [15]. Gen Z, the predominant demographic population in terms of entering the workforce in the next decade, is characterized in the 2026 Gallop, Walton Family foundation study as "navigating a complex relationship with artificial intelligence (AI) that is marked by plateauing use, declining optimism and growing concern about its impact." A 2025 Harvard poll similarly pointed to "uncertainty about the future of work" among young adults who see "fewer opportunities, greater threats to job security, and diminished meaning in their careers." Indeed, the poll results indicated that by more than a 3:1 ratio, young adults believe that AI will reduce opportunities. (Institute of Politics, Harvard Kennedy School, 2025).[16]

Youth increasingly see their futures as predetermined dead ends. Our students are deeply anxious about AI-driven futures, automated societies, massive technical and economic shifts, joblessness and labour redistribution, social isolation, the erosion of creativity, the devaluation of educational degrees, the inability to think critically—all concomitant fears of increasing robotization. This prevailing state of uncertainty around AI needs to be addressed with a critical understanding of the complex milieu of digital life and culture, a milieu of digital distraction and compulsion compounded by a perpetually emerging AI. Inspired by Samuel Beckett, Paul Abela sees Gen Z as the "Godot" generation—a generation born of 21st century technology, a generation "fated to live in a perpetual state of waiting, eagerly anticipating a sound or vibration signalling the next fleeting message to be read quickly and as quickly forgotten." (Abela,2026) [17] Attention spans are shallow and evanescent and everyday life is one of perpetual distraction and boredom punctuated by alerts.

All true perhaps, but while this digital addiction is now inextricably connected to emergent AI, there is a restlessness afoot amongst our young students that is expressed in the echoes of boos—a robust protest against AI and the erosion of critical engagement, creativity, and original and independent thinking, or even thinking itself in the process of cognitive surrender. Paradoxically of course, these same students heavily use AI and the professoriate is clambering over a seismically shifting ground to try and save critical thinking.

That our students will be expected to be AI-fluent in the career fields they pursue is not debatable. How they learn to develop such fluency and apply AI strategically and productively, critically and ethically is the challenge of enormous consequence for higher learning, its institutions, policies and pedagogies.

Artificial intelligence policies are being crafted and published at an accelerated pace. [see UC Berkeley Law, 2026 for one of the most thorough and finely detailed policies)[18] Besides the inevitable litany of rules and prohibitions, such policies must proceed from a statement on educational philosophy, ethics and obligations for students, instructors, and administration, and the urgent need for the development of independent and critical cognitive skills which must come first in the practices, quality, and above all, the ethicality of AI.

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A Six-Actor Managerial Framework for School Governance and Institutional Quality: Evidence from Field Research

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Abstract

This article develops a six-actor managerial framework to examine school governance and institutional quality, drawing on field data collected during doctoral research. The decision to keep six groups in the same analytical frame is deliberate. Principals, teachers, auxiliary and non-teaching staff, students, parents, and community actors often appear in separate institutional conversations, even though they interact with the same school from different positions. Here, governance is not reduced to leadership, regulation, or compliance. It is read through the lens of how participation, communication, transparency, accountability, collaboration, and trust are perceived by those groups. The empirical material comprises 901 valid responses collected through six actor-specific questionnaires. Overall, the responses are favorable but not flat. Communication is strong, especially for parents and community actors, while students and teachers point more clearly to tensions around influence, fairness, psychological safety, and centralized decisions. The framework is proposed as a practical reading tool for school leaders: it shows where arrangements work, where they remain mainly procedural, and where improvement should start.

Keywords: *school governance; six-actor model; institutional quality; field research; educational management; stakeholder participation*

1. Introduction

School governance is no longer only an administrative matter. For school managers, it has become a daily practical issue because schools must respond immediately to policy requirements, community expectations, internal quality assurance, and the ordinary pressures of institutional life [1], [2]. In this setting, governance is shaped not only by the management team or by formal bodies, but also by the circulation of information, the way decisions are explained, the seriousness of consultation, and the degree to which different actors understand their place in the school.

The problem can be stated plainly. A procedure may exist and still have little perceived force. A council may meet, a consultation may be announced, or a communication channel may be available, while some actors still feel that decisions have been made elsewhere. This is why the article keeps a distinction between formal governance arrangements and the lived experience of those arrangements.

The study uses a six-actor lens: principals, teachers, auxiliary and non-teaching staff, students, parents, and community actors. These groups do not have the same authority, and they do not encounter the school from the same position. That asymmetry is precisely why their perceptions are useful. Each group can reveal a different part of the institutional picture. The framework then connects these perceptions to institutional quality and identifies areas where leadership may need to explain, adjust, or redesign existing routines. The six-actor logic is summarized in Fig. 1.

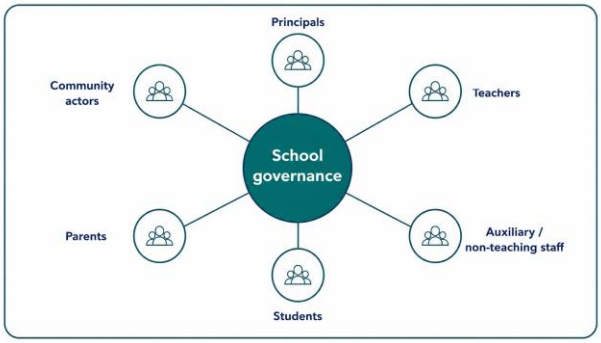


Fig. 1. Six-actor managerial framework for school governance and institutional quality

For this reason, the paper reads stakeholder perceptions as evidence that needs interpretation, not as isolated comments. Once the answers are collected in the same matrix and compared across groups, they become early warnings. They indicate where participation is felt as real, where communication already works, and where formal mechanisms have not yet produced a shared sense of influence, fairness, or trust.

2. Theoretical Background

One way to approach school governance is to focus on leadership, administrative coordination, and compliance with formal regulations [3]. This view is necessary, especially in systems where schools operate under detailed rules. It is not, however, sufficient. Schools are also social, professional, and community institutions. Decisions made inside them are interpreted, negotiated, applied, or resisted by several categories of actors [1], [4], [5].

A stakeholder-oriented reading widens the frame. Principals set direction and coordinate institutional priorities. Teachers carry policy and school decisions into classroom practice. Auxiliary and non-teaching staff maintain the daily operational conditions of schooling. Students experience the consequences of decisions directly, often before adults notice the effects. Parents bring expectations, feedback, and legitimacy from the family environment. Community actors connect the school to wider social and institutional networks. Looking at only one group would therefore leave part of the governance field outside the picture.

Institutional quality also means more than academic results or administrative compliance [2], [6]. It includes the quality of communication, the credibility of participation, collaboration, transparency, fairness, trust, and organizational culture. The distinction between formal and lived governance is useful here. Formal governance refers to written rules, structures, and procedures. Lived governance refers to what these arrangements become in practice: how they are understood, used, questioned, or trusted by those who meet them in everyday school life [7].

3. Research Design and Methodology

The empirical part of the research is based on a descriptive-interpretative quantitative design. Six questionnaires were used, each adapted to the institutional position of one actor group [8], [9]. The study did not aim to test a causal model. Its purpose was more modest and, for school management, more practical: to describe how key groups perceive governance-related dimensions and to identify differences that may guide managerial interpretation.

The instruments were developed around a common governance matrix. Even so, the wording was adjusted for each respondent category. A student, a teacher, a parent, and a community partner do not meet school governance from the same place. The main dimensions included participation and voice; leadership and decision-making; communication and transparency; institutional climate and trust; collaboration; inclusion; digitalization; and institutional support.

The questionnaires used five-point Likert-type scales. Since these data express ordered perceptions, the analysis relies on descriptive and comparative indicators, not on claims of objective measurement [10], [11], [12]. Negatively formulated items, including those referring to centralization, formal consultation, fear of contesting decisions, favoritism, or bureaucratic obstacles, were examined separately. When they entered synthetic scores, they were reverse-coded using the formula: adjusted score = 6 - raw score.

The final dataset includes 901 valid responses. It is not presented as nationally representative. Its value lies elsewhere: it allows the same school governance field to be read through several categories of experience, so that convergences and tensions become visible simultaneously.

Table 1. Respondent structure

Actor group	Number of responses
Students	282
Teachers	144
Parents	338
Principals	34
Auxiliary/non-teaching staff	71
Community actors	32
Total	901

4. Results

The respondent structure allows the governance field to be viewed from several institutional angles. Parents and students form the largest groups in the dataset. Principals and community actors are smaller groups, so their results must be read with more caution. Their presence is still important: governance is not experienced only by the most numerous actors. It is also experienced by actors who hold strategic or boundary positions in the school ecosystem.
The adjusted scores indicate a generally favorable view of school governance. Parents record the highest overall score (4.24). Teachers and principals have the same score (4.11), followed by auxiliary/non-teaching staff (4.09), community actors (4.07), and students (3.92). The students' score is still above the scale midpoint; however, it is the most reserved among the six groups and therefore warrants attention.

Table 2. Overall adjusted descriptive scores by actor group

Actor group	Overall adjusted score
Parents	4.24
Teachers	4.11
Principals	4.11
Auxiliary/non-teaching staff	4.09
Community actors	4.07
Students	3.92

4.1 Communication as a Strong Governance Dimension

Communication is one of the clearest strengths in the dataset. Parents describe communication channels as accessible and consider information about school rules generally clear. Community actors also evaluate communication with the partner institution positively, especially regarding available channels and the willingness to maintain collaboration.
At the classroom level, teachers and students both report favorable communication. Teachers mention encouraging questions and giving feedback, while students acknowledge classroom dialogue. This is a significant result, but it should not be overread. Communication shows that information and interaction are present; it does not, by itself, prove that stakeholders have influence over institutional decisions.

4.2 Formal Participation and Perceived Influence

The results also show a recurring distance between formal participation and perceived influence. Student councils, parent councils, administrative boards, and other representative mechanisms are visible in the institutional landscape. Their presence, however, does not always convince stakeholders that their contribution changes decisions.
Students provide the clearest signal. They value classroom dialogue and believe that students should be consulted when important school decisions are made. At the same time, weaker scores appear on items referring to actual influence, especially when decisions seem to be taken before consultation or when influence appears unequally distributed. Parents show a related pattern: communication with the school is strong, but consultation can still feel procedural rather than consequential.

4.3 Institutional Climate, Trust, and Psychological Safety

The institutional climate is assessed positively overall, but the picture is not without sensitive areas. Students usually report respectful relations with teachers. Auxiliary and non-teaching staff also report respect from students, parents, and teachers. Lower adjusted scores appear when the questions move from everyday politeness to impartiality, the possibility of contesting rules, and confidence that problems can be reported safely.
This distinction matters for governance analysis. Climate is not only about friendliness or polite interaction. It also includes psychological safety, the perception that rules are applied fairly, and the belief that disagreement can be expressed without negative consequences. These are the points where formal procedures must be connected to lived trust.

5. Discussion

The results support a multi-actor reading of school governance. Principals and teachers remain central, but they do not exhaust the whole institutional reality of the school. Students, parents, auxiliary/non-teaching staff, and community actors bring into view issues that a leadership-centered analysis could easily miss.

The first discussion point concerns formal and lived governance. The formal structures of participation are present and recognized, but their perceived force differs. Some stakeholders know representation exists, but still do not experience it as a genuine route to influence. For institutional quality, that difference is not marginal. A school does not improve simply by having structures on paper. It improves when those structures are understood, trusted, and connected to visible responses [1], [7].

The second point concerns communication. The data suggest that a school may communicate relatively well and still leave some stakeholders uncertain about influence. This is not a contradiction. Communication often carries information from the institution to the stakeholder. Participation requires one more step: the institution must show what happened after stakeholder input was received. For this reason, transparency needs feedback loops and evidence that consultation has consequences [1], [2].

The third point concerns teacher agency. Teachers report strong dialogic practices in classrooms, which suggests that participatory routines may be more visible in pedagogical interaction than in institutional decision-making [13], [14]. The fourth point concerns fairness and psychological safety. Lower scores on fear of contesting decisions, preferential treatment, and reluctance to report problems indicate that governance quality is tied to trust, not only to compliance [6].

6. Managerial Implications

The first implication is to move from formal participation to participation that leaves a trace. Councils, committees, and consultation moments should not only exist. Stakeholders should be able to see what happened to their proposals: whether they were discussed, accepted, revised, postponed, or rejected. Without this visible return, consultation can easily be read as a ritual rather than as a route to influence.

A second implication follows from the strong communication results. Because communication is already a relative strength, schools can use it as a base for deeper participation. Communication channels can become feedback channels, and information meetings can be linked to structured consultation. In practical terms, this may mean short reporting notes after consultations, accessible decision summaries, and recurring opportunities for actor-specific feedback.

Student voice requires particular attention. The data show that students experience classroom dialogue more positively than institutional influence. A practical response would be to strengthen student feedback forums, make student councils more visible, and consult students on decisions that directly affect their school experience [15].

Teacher participation also requires attention. Teachers should be treated not only as implementers of decisions, but as institutional contributors. Auxiliary and non-teaching staff should be included more clearly in consultation and resource-related discussions. Finally, school-community collaboration should be organized through stable communication channels, clear agreements, and realistic expectations, so that the partnership does not remain dependent on informal goodwill [1], [16].

7. Main Contribution of the Study

The main contribution of the article is the empirical grounding of a six-actor managerial framework for school governance and institutional quality. The model brings together principals, teachers, auxiliary/non-teaching staff, students, parents, and community actors within the same analytical frame.

The study contributes in three ways. Conceptually, it separates the existence of governance structures from the influence that stakeholders actually perceive. Empirically, it uses 901 responses collected from six actor groups. Managerially, it treats differences in perception as useful diagnostic signs, not as minor variations in opinion.

For school leaders, the framework offers a compact instrument of institutional reflection. It helps identify who perceives what, where formal procedures do not become meaningful participation, and which areas require intervention in communication, consultation, fairness, psychological safety, inclusion, or collaboration.

8. Conclusions

This article examined school governance and institutional quality through a six-actor managerial framework grounded in field research. The results are generally favorable, but they also show that governance is not experienced in the same way by all groups. Communication, classroom dialogue, and willingness to collaborate are stronger dimensions. The more vulnerable areas concern perceived influence, the distance between formal consultation and real participation, psychological safety, fairness, and transparency of resources.

The practical conclusion is straightforward: institutional quality does not depend only on adopting governance structures. It also depends on whether those structures are understood, experienced as meaningful, and linked to feedback and collaboration routines. Stakeholder perceptions can therefore work as an early diagnostic instrument. Differences between actor groups are not just statistical details; they can point to places where explanation, dialogue, or redesign is needed.

Although the empirical data are context-specific, the proposed framework may be relevant to European education systems concerned with stakeholder participation, institutional quality, and school-level governance.

The study has limitations. It relies on self-reported perceptions and should not be read as an objective measurement of governance quality. The sample is contextual and unevenly distributed, and smaller groups such as principals and community actors require cautious interpretation. Future research should combine questionnaires with interviews, focus groups, document analysis, and longitudinal validation in different school contexts.

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ChatGPT's Performance and the Use of Argumentative Structures in Romanian Educational Contexts

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Abstract

This study examines the performance of ChatGPT in generating argumentative essays for various levels of Romanian education, assessing its adherence to required argumentative structures and evaluation criteria. The research involves three sets of real-life writing tasks: the 8th-grade national assessment, the 12th-grade baccalaureate, and the Titularizare and Definitivat exams for teachers (Tenure Exam for Teachers, Final Teaching Qualification Exam). These tasks are processed by ChatGPT, and the resulting essays are analyzed in collaboration with MA students specializing in curriculum development for Romanian language and literature. By applying corpus linguistics methods, this study seeks to analyze the frequency, variation, and function of lexical bundles in ChatGPT-generated essays for Romanian exams. The aim is to determine whether AI writing displays the same level of syntactic and semantic variation as human writing or whether it follows predictable, repetitive structures, reinforcing concerns about its formulaic nature [1]. Additionally, the research focuses on the coherence and cohesion of AI-generated arguments, and the degree of conformity to the structural and stylistic expectations outlined in national evaluation standards. The findings of this study will provide insights into both the pedagogical implications of AI-assisted writing [2,3] and potential challenges in assessing AI-generated texts within standardized educational frameworks. By comparing AI outputs with human-graded essays, the research will contribute to the ongoing debate on the role of artificial intelligence in language education, assessment, and the development of argumentative competence in Romanian academic contexts.

Keywords: *AI-generated writing; AI-assisted writing; argumentative structures; writing evaluation; Romanian national evaluation standards*

1. Introduction: Use of AI in Educational Contexts (Writing Tasks)

In recent years, large language models (LLMs), such as Open AI's ChatGPT, Google's Bard, Meta's LLaMA, and Anthropic's Claude, have rapidly entered educational settings. These LLMs are all based on advanced transformer architectures and have raised both enthusiasm and concerns about their ability to support student writing and academic expression [4, 5], as well as the ethical implications of their use. Much of the existing research focuses on diverse global contexts. However, the Romanian educational system remains relatively conservative, emphasizing traditional pedagogical methods and strict compliance to formal academic standards. In this system, the ability to construct coherent, well-structured argumentative texts is considered a core competency essential not only in high school but also in university education. Argumentative writing is a core component of national evaluations and high-stakes examinations, particularly at the end of secondary and upper secondary cycles. These tasks typically require the structured articulation of a thesis, the development of coherent arguments supported by relevant examples, and clear conclusions. These criteria are explicitly outlined in the national curriculum and assessment rubrics.

This research explores the intersection of digital pedagogy, AI-assisted writing, and assessment literacy by analyzing how ChatGPT aligns with – or deviates from – these expectations. Previous research has shown that although AI-generated texts can exhibit high surface-level fluency, they often struggle with deeper discursive functions, such as argumentation, critical engagement, and contextual adaptation [6]. In the Romanian context, where evaluation criteria emphasize logical consistency, relevance, and clarity of argumentative progression, it is essential for educators, curriculum designers, and policymakers to understand the capabilities and limitations of such tools. This is particularly important since argumentative writing skills are evaluated through Baccalaureate exams, as well as key professional certification and recruitment tests, such as the Definitivat and Titularizare exams. These exams serve as gateways for teachers to enter the educational system.

This study uses a qualitative, rubric-based analysis of ChatGPT-generated essays aligned with Romanian school, Baccalaureate, and teacher certification standards to investigate the structural integrity of the outputs and the discursive strategies employed. Additionally, the study reflects on the implications of integrating LLMs into writing instruction, particularly in contexts where argumentative competence is closely tied to exam performance and broader educational outcomes.

Despite the growing international interest in corpus-assisted writing analysis and AI-based textual evaluation, Romania lacks a dedicated corpus of pre-university student writing, especially argumentative texts. Romanian corpus linguistics is underdeveloped in key educational areas and there is limited infrastructure for systematically analyzing student writing below the university level. While efforts such as the ROGER platform, the Corpus of Romanian Academic Genres, represent significant steps toward supporting undergraduate academic writing [7], no comparable learner corpus is currently available for secondary or high school writing. This absence hinders the empirical evaluation of how students perform in relation to national argumentative standards. Thus, this study examines ChatGPT's outputs and highlights the need for a corpus tailored to pre-university genres. Such a corpus would provide a more data-driven foundation for pedagogy and assessment.

In addition to the lack of a dedicated corpus for high school writing, recent research on university-level student writing reveals substantial discrepancies in writing pedagogy and student performance across educational transitions. In a larger research group, we conducted several corpus-based contrastive studies. One study examined how well-prepared Romanian high school students are for academic writing in higher education [8]. This study revealed notable discrepancies between the writing practices promoted in secondary education, which are often reproductive, prescriptive, and exam-oriented, and the expectations of university-level writing. University-level writing requires analytical, discipline-specific, and rhetorically competent production. Similarly, Crașovan and Rogobete [9] analyzed literary text analysis essays produced by third-year undergraduate students. They compared exam-based writing with texts written in a blended/online format and found that corpus tools can reveal structural, lexical, and discursive tendencies often overlooked in traditional assessment. These studies support the idea that there is an imperative need for enhanced pedagogical strategies and empirical resources that reflect the realities of student writing at multiple educational stages. In this context, evaluating how ChatGPT mimics or diverges from real student output can offer insight into its potential as a writing assistant.

2. Study Design and Research Steps

For this study, a group of MA students specializing in curriculum development for Romanian language and literature was divided into three teams, each focusing on a different level of Romanian educational assessment: the National Evaluation (8th grade), the Baccalaureate Exam (12th grade), and the Definitivat and Titularizare teacher certification exams *(Tenure Exam for Teachers, Final Teaching Qualification Exam)*. Each team was tasked with systematically gathering data from the past decade (approximately 2014–2025) and targeting all official exam items requiring argumentative or discursive essays. The students collected these materials from official educational platforms and archives, then compiled the essay prompts into a structured Excel database.

In the second phase, the teams identified and curated a set of human-written responses corresponding to the selected prompts. These sample essays were sourced from various publicly available materials, including educational anthologies and exercise books published before the advent of GenAI, older forum posts, personal collections, and texts shared among peers. This ensured that the samples represented authentic pre-AI writing practices reflective of real student performance across multiple years.

Next, the same prompts were entered into ChatGPT, and the model was instructed to generate responses mirroring the exam format. The AI-generated essays were then compared with the human-written to evaluate structural fidelity, argumentative coherence, lexical complexity, and alignment with national evaluative criteria.

After the data collection and generation phases, the task supervisors (tutors) manually processed the essay samples. Their goal was to synthesize a third category of responses: hybrid texts integrating elements from the human- and AI-generated versions. They created these mixed essays by carefully selecting and combining structurally relevant and stylistically coherent segments from each version. This ensured that the hybrid texts preserved argumentative integrity while reflecting realistic language use.

The triadic dataset, comprising original human-written responses, ChatGPT-generated essays, and manually curated hybrid texts, was then submitted to a new group of student participants (Group 1). This group consisted of prospective teachers who were not involved in the initial data collection or synthesis process. The students received the official national evaluation rubric corresponding to their exam level and were asked to assess all three versions of each essay simultaneously.

To ensure impartiality and eliminate bias, the participants were not informed about the origin of each text. All responses were anonymized and randomized so the raters could not identify whether they were assessing a human-, AI-, or hybrid-written text. This blind evaluation setup permitted a more objective analysis of how ChatGPT's writing is perceived compared to authentic student work, as well as how a human-AI collaboration model could affect assessment outcomes in Romanian educational contexts.
The evaluation results revealed a clear pattern across the three assessment categories. Specifically, ChatGPT-generated essays received lower scores than human-written essays at two out of three exam levels. Conversely, purely human-produced texts were consistently rated higher in these two categories, reflecting stronger adherence to the argumentative structures and evaluative criteria of the national rubric.
These results suggest that, while ChatGPT can generate coherent and contextually relevant essays, it may lack depth of argumentation, contextual appropriateness, and rhetorical sophistication. These results also underscore evaluators' ability to distinguish between human and AI writing in terms of meeting established academic standards in the Romanian educational context.
Interestingly, the third exam level showed a smaller scoring difference between human and ChatGPT essays, suggesting a potential convergence in performance or variation in evaluative stringency. These findings highlight the challenges of integrating AI-generated text into formal educational assessment frameworks and suggest areas for pedagogical intervention and AI model refinement to more effectively support the development of academic writing skills.
AI capabilities to enhance argumentative clarity, language sophistication, and overall coherence.
After a thorough evaluation, which will be analyzed later in this study, the same focus group was given an additional assignment. They had to use ChatGPT to create an improved version of each of the purely human-written essays. The students were provided guidance on how to effectively tailor their prompts to maximize the quality of the model's output. Through this iterative process, they created a fourth version of each essay, combining human insight and AI capabilities to enhance argumentative clarity, language sophistication, and overall coherence.
A second focus group was convened one week later to independently assess a new set of essay samples using the same evaluation rubric and anonymized procedure. This group, composed of prospective teachers who had not participated in previous project phases, was tasked with evaluating three versions of each essay prompt: (1) the original ChatGPT-generated version, (2) the original human-written version, and (3) the enhanced version created by the first focus group through a human-AI collaborative process.
As in the initial evaluation round, all essays were anonymized and randomized to ensure a blind assessment process and minimize bias. The evaluators scored each version based on adherence to the rubric, its coherence, its language use, and the presence of critical thinking, while also providing qualitative observations. The goal of this second round was to test the consistency of evaluations across different rater groups and measure whether the collaboratively improved version (Version 3) showed measurable gains in quality and performance compared to the original outputs. Triangulating these evaluations allowed for a more robust analysis of AI capabilities and the pedagogical potential of guided human-AI revision workflows in Romanian argumentative writing contexts.
In this evaluation round, a consistent pattern emerged. The enhanced versions (Version 3), which were developed through human-AI collaboration by the first focus group, received the highest scores across all prompts. This was compared to purely human-written essays and ChatGPT-generated essays. These results suggest that guided integration of AI-generated suggestions, mediated by human evaluators with pedagogical training, improves argumentative clarity, structural coherence, and linguistic refinement. These results reinforce the potential of AI tools as instruments for targeted, tutor-led enhancement of student writing, rather than as standalone writing agents.

3. Student Evaluation of ChatGPT's Academic Writing Performance

Prior to participating in this study, students had varying degrees of experience with generative AI tools, particularly ChatGPT. According to a preliminary questionnaire, 55.6% of participants reported using ChatGPT to some extent; 33.3% reported minimal prior use; and 11.1% stated that they used it extensively in academic or related contexts.

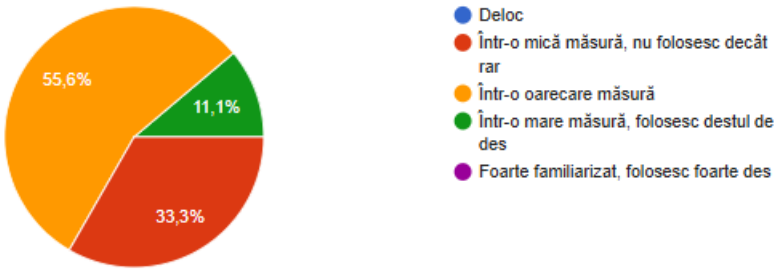


Fig. 1. Students' prior experience with ChatGPT

Reported use cases ranged from basic lexical tasks, such as synonym searches and text reformulation, to grammar checks and obtaining contextual information on literary texts. Some students used ChatGPT to summarize lengthy texts they did not have time to read or to help organize content, finding it useful within limited, well-defined parameters. However, others expressed strong skepticism, citing instances in which the model produced inaccurate corrections, contradictory grammatical explanations, or fabricated bibliographic sources.

The students' prior engagement levels directly influenced their approach to the research tasks in this project. Those with limited experience were more curious, yet more cautious, when evaluating AI-generated content, especially during the blind assessment phase. Conversely, students who regularly used ChatGPT were more confident in crafting prompts and guiding the tool during the enhancement phase. During this phase, they improved human-written essays with AI assistance. This range of prior familiarity underscores the importance of integrating AI literacy into writing pedagogy. Such an integration would enhance students' technical interaction with tools like ChatGPT and foster their critical awareness of the tool's limitations and potential in academic contexts.

At the end of the study, participants evaluated ChatGPT's effectiveness based on a series of criteria relevant to academic writing. Their responses, collected on a 5-point Likert scale, revealed a nuanced perception of the tool's capabilities and limitations.

Table 1. Evaluation - 5-point Likert scale

• ChatGPT responded effectively to the specific requirements of the academic writing tasks.
• ChatGPT helped me save time and effort in the writing process.
• Using ChatGPT contributed to the development of ideas in writing.
• The suggestions received through ChatGPT improved the overall quality of the texts.
• The suggestions received through ChatGPT improved the overall content of the texts.
• The suggestions received through ChatGPT improved the overall coherence of the texts.
• The suggestions received through ChatGPT improved the text structure.
• The suggestions received through ChatGPT improved the clarity of the texts.
• The suggestions received through ChatGPT created a more elaborate expression.
• I noticed an improvement in Romanian expression following the use of ChatGPT.
• Overall, the text "improved" with ChatGPT would receive a higher score in evaluation.
• I noticed a more elevated language style in texts following the use of ChatGPT.
• ChatGPT aligns well with the indicators in the rubric.

The student evaluators focused their analysis on several key dimensions aligned with the national assessment rubric. First, they examined the extent to which each essay met the rubric's specific criteria and whether all required points were adequately addressed. Second, they evaluated the essay's coherence at both the argumentative and discursive levels. They considered the text's structural and formal organization, as well as the depth and clarity of its ideas. Third, they assessed the language used, considering whether the text exhibited clichéd or automatic expressions and predictable, repetitive structures, or more elaborate, academic, and original phrasing.

Additionally, the evaluators assessed whether the author demonstrated critical thinking skills, an essential component of argumentative writing. Finally, they reflected on the rubric itself, questioning its ability to balance content and form and reward all components of good writing, particularly critical thought and argumentative skills.

Students generally found ChatGPT's interface to be intuitive and easy to use, giving it an average score of 4.11. This suggests that user-friendliness is one of the tool's strengths. However, the average rating

was more reserved at 3 out of 5 when asked whether ChatGPT effectively responded to the specific requirements of academic writing tasks, suggesting moderate satisfaction with its relevance to and adaptability to these tasks.
While some students acknowledged the time-saving benefits of ChatGPT (mean score: 3.11), most did not report increased confidence in their academic writing, as reflected by an average score of 2.11. Similarly, students' perceptions of ChatGPT's contributions to idea development, text quality improvement, content enhancement, and coherence were modest (mean scores of 2.66, 2.66, 2.44, and 2.55, respectively). These results suggest that students viewed the tool more as a drafting aid than a transformative writing assistant.
Several concerns also emerged. Students expressed skepticism about ChatGPT's alignment with national assessment rubrics (mean score: 2.77) and noted that its suggestions often failed to meet rubric expectations (mean score: 4.22). Additionally, students felt that ChatGPT might reduce original expression (mean: 4.44), raising concerns about academic integrity and stylistic authenticity. Students rated the tool's capacity to improve Romanian writing low (2.0) and doubted that a ChatGPT-enhanced text could outperform a human-written text in formal evaluations (2.0).
Students reported difficulty distinguishing between accurate and inaccurate suggestions provided by the model (mean: 3.22), underscoring the need for critical digital literacy when using generative AI in writing contexts. Furthermore, students rejected the idea that ChatGPT reduces the need for traditional academic resources, such as courses, books, or scholarly articles. This reinforces the perception that AI should complement, not replace, formal instruction.
Despite these reservations, students largely supported including ethical AI use in educational curricula, giving average ratings of 4.0 and 3.77 for university and high school, respectively. However, only 23.3% of respondents would recommend ChatGPT to improve academic writing skills, and an even smaller percentage believed it could "compete" with human candidates taking the Romanian language exam (17.7%).
These results highlight a central paradox in the pedagogical use of generative AI: while students appreciate tools like ChatGPT for their accessibility and drafting potential, they remain cautious about their educational value, accuracy, and alignment with institutional standards. The findings suggest that future implementations should include explicit instruction on prompt engineering, rubric-based revisions, and ethical use in order to foster informed and critical engagement with AI technologies in the development of academic writing.

3.1 Student Reflections on Effective Prompting Strategies for ChatGPT

When asked to reflect on the most effective prompting strategies in their interactions with ChatGPT, students shared insights from both positive and negative experiences. Several participants found that using a "persona-based" approach – instructing ChatGPT to write from the perspective of an exam evaluator, for example – resulted in more coherent and structured responses. In contrast, those who experimented with evaluator and candidate personas were disappointed by inconsistent or irrelevant outputs, despite providing full prompts and rubrics.
Students recommended formulating clear, specific instructions, especially those emphasizing the use of natural, human-like language. One student pointed out that ChatGPT performs better when asked to maintain a consistent discourse style throughout the response. They also warned against combining too many prompt directions within a single thread. Maintaining prompt continuity across separate chats was considered a beneficial strategy to avoid confusion in task execution.
A user's familiarity with ChatGPT significantly influences how effectively the tool is used and the quality of its results. Students who understand how to craft precise, context-aware prompts tend to receive more relevant, nuanced, and stylistically appropriate outputs. In this sense, AI performance reflects not only its capabilities but also the user's skill in guiding it, demonstrating that stronger students often produce stronger results simply because they know how to ask better questions.
Some students suggested that ChatGPT's strengths lie in providing micro-level assistance, such as generating synonyms, rhymes, or reformulations, rather than producing complete academic essays. However, others noted that the model can produce discipline-specific technical language, which can be useful for achieving a scholarly tone.
Overall, students emphasized the importance of providing detailed instructions for a task, guiding the model through the structure of a response rather than relying on it to generate a solution independently. One participant articulated this distinction, noting that ChatGPT is more effective when asked to suggest ways to solve a task than when asked to provide a final answer. This reflects students' growing

awareness that AI should be used as a process facilitator rather than a product generator, which reinforces the pedagogical shift toward collaborative human-AI writing practices.

3.2 Limitations in ChatGPT's Output and the Need for Prompt Reformulation

When asked to identify types of prompts or aspects of tasks to which ChatGPT responded inadequately or failed to meet expectations, students highlighted several recurring challenges requiring prompt reformulation, clarification, or multiple iterations. One of the most frequently mentioned issues was textual coherence and logical idea sequencing. Students noted that ChatGPT often used bullet points or short, disjointed sentences instead of producing integrated, fluent prose suitable for academic writing. Another commonly reported limitation was the tool's tendency to use formulaic or clichéd expressions, even when instructed not to. Similarly, students had difficulty eliciting grammatically correct or stylistically nuanced revisions, especially in contexts requiring more humanized or context-sensitive language. In some cases, the grammatical corrections were inaccurate and resulted in awkward reformulations requiring close human review.

Tasks requiring detailed reasoning, justification, or evidence-based arguments—such as including citations or quotations—were also flagged as problematic. Students remarked that ChatGPT sometimes produced irrelevant content or fabricated sources, which undermined the credibility of the output.

Some participants noted that the model struggled with complex prompts requiring layered instructions or in-depth elaboration. Furthermore, the model often failed to eliminate redundancies or avoid repeating previously stated ideas, resulting in repetition and circular arguments.

While a few students reported no major difficulties, the majority emphasized the need to verify and revise AI-generated content to achieve more authentic, contextually appropriate, and original expression. As one student remarked, ChatGPT can generate "pearls" of expression that are not always appropriate or logically integrated, which underscores the importance of human oversight in AI-assisted writing.

4. Pedagogical Implications: Integrating AI in Teaching and Academic Writing

The findings of this study suggest a promising pedagogical approach: when used strategically and reflectively, artificial intelligence can support the development of academic writing skills rather than replace or undermine them. The superior performance of the enhanced (human-AI collaborative) essays suggests that, when critically mediated by learners or tutors, AI-generated content can serve as a scaffold for improving argumentative structure, lexical richness, and overall coherence when critically mediated by learners or tutors.

Students' ambivalent responses regarding the use of AI in academic writing reflect the concerns raised in current educational research. Students appreciate AI tools' ability to facilitate idea generation, language reformulation, and structural organization, particularly in the early stages of writing. As several participants in this study noted, AI can serve as a cognitive scaffold that helps students overcome writer's block, organize their thoughts, and identify more academic phrasing. These benefits align with studies recognizing AI's potential to support personalized learning environments and writing feedback systems.

However, these benefits are counterbalanced by critical risks. Students expressed concern that frequent AI use might diminish originality, independent reasoning, and the ability to critically engage with academic sources—an issue also addressed in educational ethics literature.

Participants also expressed concern about overreliance on AI as a shortcut, which could lead to a loss of skills and reduce academic integrity if tools are used to generate student work entirely instead of to support it. Plagiarism by proxy and the undetected incorporation of false or fabricated information further undermine the reliability of AI-generated content. Consistent with this, students in the present study emphasized the importance of critical verification and the necessity of viewing AI as an instrumental aid rather than a writing surrogate. Their comments point to an emerging consensus in research. AI integration in educational contexts should be accompanied by explicit training in prompt design, source evaluation, and ethical usage [10]. At the same time, higher education institutions – including those in Romania – should be encouraged to adopt a multi-level disclaimer policy regarding the use of AI, ensuring clarity about permissible practices, responsibilities, and limitations at both institutional and course levels.

Together, these insights underscore the necessity of reimagining writing pedagogy within an AI-driven academic environment and shifting away from the simplistic utility-versus-threat dichotomy. Instead, what is required is a balanced framework for AI literacy that fosters critical agency and metacognitive awareness in student writers.

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Enhancing Student Engagement

Reimagining the Student Experience through Engagement, Rigor and Support

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Abstract

This paper presents a comprehensive, research-aligned model designed to support gifted and high-achieving students through systems that strengthen instruction, expand equitable access, and provide sustained academic and social-emotional supports. The initiatives implemented—including collaborative professional learning, continuous coaching cycles, redesigned Advanced Placement pathways, and enhanced student support structures—demonstrate how coordinated schoolwide efforts elevate instructional quality and foster meaningful inclusion in advanced coursework. Together, these strategies illustrate how rigor, equity, and targeted supports can coexist to promote long-term student success within high-performing academic environments.

Keywords: *support, peer mentoring, access*

Introduction

Supporting students' learning is critical to their overall achievement, especially within gifted and high-achieving populations. Research demonstrates that gifted students require consistent exposure to challenging and complex tasks to avoid disengagement and underachievement [11]. These students benefit from environments that promote cognitive depth, autonomy, and opportunities for advanced problem-solving, while still receiving targeted support that nurtures their social-emotional and academic needs [9]. As a school leader working with this student population, my challenge was to balance rigorous expectations with individualized support systems that enabled all learners to thrive.

To achieve this, I implemented several interlocking initiatives. First, I developed a structured system of professional learning for teachers that included lesson study, mentoring, and individualized coaching. Teacher collaboration is one of the most effective drivers of school improvement, increasing collective efficacy and enhancing instructional quality [6]. Research on lesson study consistently shows that collaborative cycles of planning, observing, and reflecting lead to improved instructional practice and deeper pedagogical knowledge [10]. As a result, teachers in our building engaged in ongoing professional reflection and expanded their instructional strategies through collegial dialogue.

Second, I instituted a cycle of evaluative and non-evaluative observations designed to provide timely, actionable feedback. Instructional coaching research indicates that job-embedded coaching, grounded in structured pre-observation meetings, observation, and post-observation feedback sessions, significantly enhances teaching effectiveness and increases implementation of evidence-based practices [9]. Frequent, specific feedback is a critical factor in teacher growth, and these cycles helped ensure that instructional improvement remained a consistent schoolwide focus.

Third, to promote equity and expand access to rigorous coursework, I redesigned our Advanced Placement (AP) enrollment system by removing recommendation-based gatekeeping and developing AP course pathways beginning in ninth grade. National studies reveal longstanding inequities in AP enrollment for Black, Hispanic, and low-income students, even within schools offering numerous AP options [2]. The College Board has long advocated for open access and expanded pathways as strategies to increase equity and college readiness [3]. By restructuring our approach, we opened doors for students previously excluded from advanced academic opportunities and fostered a mindset that values growth, challenge, and long-term learning over narrow outcome metrics.

To support students' success within these advanced pathways, I estabilised peer-mentoring programs, tutoring structures, and counseling supports. Peer mentoring has been shown to improve academic performance, increase student persistence, and strengthen students' sense of belonging during critical academic transitions [4]. These structures helped ensure that all students—especially those new to AP coursework—received ongoing academic and social-emotional support.

Finally, I revised the schoolwide grading policy by extending marking periods and requiring all teachers to integrate performance-based assessments. Research shows that performance assessment enhances students' higher-order thinking, provides more authentic demonstrations of learning, and aligns with best practices in formative assessment [4]. Longer grading cycles also allow teachers to receive meaningful feedback and give students the time necessary to engage in iterative practice and revision—critical elements of deep learning.This shift aligned assessment with instructional goals and created more equitable and meaningful measures of student mastery.

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Enhancing Project Outcomes in First-Year PBL Courses through Increased Teaching Sessions

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Abstract

The quality of student projects in a first-year Computer Architecture course has long been a concern, with many submissions reflecting insufficient mastery of foundational concepts and a lack of confidence to tackle challenging tasks. These issues are compounded by students' limited base knowledge and undeveloped self-learning abilities, which are critical for success in project-based learning (PBL). To address these challenges, the course's teaching sessions were doubled from six to twelve, while assignments were redesigned to integrate knowledge from multiple sessions. This intervention aimed to provide a stronger foundation, foster self-learning, and enhance project outcomes. The results showed significant improvements in student performance and confidence. Project grades increased substantially, with more than 50% of students achieving a grade of B or higher in 2024, compared to only 25% in 2023. Students reported greater confidence in undertaking challenging projects, with over 80% attributing this to the enhanced teaching sessions. Self-learning also improved, as 84% of students independently explored advanced topics like sensor integration and communication protocols to complete more sophisticated projects. Despite the reduction in project implementation time from 15 to 6 weeks, the projects demonstrated higher complexity and quality, underscoring the critical role of foundational instruction. This study highlights the importance of integrating structured teaching sessions with guided assignments to bolster foundational knowledge and promote self-learning. The findings provide actionable insights for improving PBL frameworks, contributing to enhanced educational practices in engineering and related disciplines.

Keywords: *Project-based learning; Foundational instruction; Teaching sessions; Self-directed learning; Engineering education.*

1. Introduction

Project-based learning (PBL) has become an integral part of engineering education as it has been recognized for its effectiveness in enhancing student engagement and bridging the gap between theoretical knowledge and practical application. Recent studies have demonstrated that PBL enables students to cultivate essential technical skills as well as fosters critical thinking, problem-solving abilities, and collaborative learning [1–4]. In the context of engineering education, PBL offers practical means for students to understand abstract concepts by allowing them to apply them in tangible ways [5–7]. This hands-on approach not only enhances understanding but also prepares students for the dynamic challenges of the engineering profession.

Despite the benefits of PBL, first-year students often encounter significant challenges when engaging in project-based assignments within the Computer Architecture course. Their limited foundational knowledge and inexperience can make the transition from structured learning environments to independent project work particularly daunting [8]. Many students exhibit a lack of confidence in selecting appropriately challenging tasks and possess insufficient skills to effectively tackle complex problems [9–12]. This is further exacerbated by the steep learning curve associated with Computer Architecture concepts, which necessitate a solid grasp of both hardware and software principles. Consequently, the quality of submitted projects has been consistently subpar, leading to overall poor performance in project evaluations.

The persistent issue of low-quality project submissions highlights a critical problem in the current educational approach. Specifically, the inadequate number of teaching sessions which was originally limited to six teaching sessions in our case study appears insufficient for first-year students who are still adapting to university-level expectations and learning methodologies. Limited instructional time constraints students' ability to fully comprehend course material, develop essential skills, and build the

confidence required to engage deeply with challenging projects [13]. This gap not only adversely affects their academic outcomes but also impedes their development as self-directed learners, a crucial attribute in the rapidly evolving field of computer engineering.
In response to these challenges, the purpose of this study is to evaluate the impact of increasing the number of teaching sessions from six to twelve in a first-year Computer Architecture course. The rationale behind this intervention is to provide students with additional instructional time to reinforce their understanding of fundamental concepts, thereby enhancing their capacity to apply this knowledge in project settings. By extending the teaching sessions, we aim to offer more opportunities for guided learning, hands-on practice, and personalized feedback which are all essential for developing competence and confidence in novice learners.
The objectives of this study are threefold. First, we aim to enhance students' knowledge base by covering more content in greater depth and providing additional resources for learning. Second, we seek to improve students' self-learning abilities by equipping them with strategies and tools for independent study, critical thinking, and problem-solving. Third, we intend to improve project outcomes by enabling students to undertake more ambitious projects with a higher likelihood of success, thereby fostering a sense of achievement and motivation.
The significance of this study extends beyond the immediate context of the Computer Architecture course. By examining the effects of increased instructional time on student performance and learning experiences, the findings have the potential to inform teaching practices in similar educational settings. Educators and curriculum designers can leverage these insights to optimize course structures, allocate resources more effectively, and implement strategies that support student learning and engagement. Ultimately, this study contributes to the broader discourse on enhancing engineering education by identifying practical solutions to common pedagogical challenges.
The rest of this article is organized as follows. Section 2 presents the methodology that guided this study. Section 3 discusses the results obtained while 4 concludes the paper.

2. Methodology

This section outlines the research design, the course and participants, the course structure, the intervention, and the evaluation methods.

2.1 Research Design

The study employed a mixed-methods comparative research design to evaluate the impact of increasing teaching sessions from six to twelve on student outcomes in a first-year Computer Architecture course. The mixed-methods approach integrates both quantitative and qualitative data to provide a comprehensive understanding of how the intervention affects students' knowledge acquisition, self-learning abilities, and project performance. On the other hand, the comparative aspect of the study involves analyzing and contrasting data collected from two distinct cohorts of students: one that experienced the original six teaching sessions (the control group) and another that participated in the enhanced twelve teaching sessions (the experimental group). By comparing these groups, the study aims to isolate the effects of the increased instructional time on various learning outcomes.

2.2 The Course and Participants

The course used in the study was Computer Architecture, a five-credit points course taken by first-year students in Bachelor of Engineering – Telematics, at the Norwegian Defense University College, Norway. The course aims to provide students with an understanding of the important building blocks of a computer and the connection between these building blocks (hardware) and the software that controls them. The study involved first-year students enrolled in the Computer Architecture course over two consecutive academic years. The control group consists of students from the year before the intervention, while the experimental group includes students from the year when the increased teaching sessions were implemented. Both cohorts consist of approximately the same number of students (e.g., 40 students per cohort) to ensure comparability.

2.3 The Course Structure

Over the years, the fundamental knowledge of the course has been provided through six teaching sessions, each accompanied by an assignment designed to reinforce the concepts covered (one

assignment per teaching session). This structure aimed to equip students with a foundational platform for self-learning and enable them to deliver challenging projects for evaluation. The topics covered in each session, along with their accompanying assignments, are summarized in Table 1.

Table 1. Teaching sessions and their accompanied assignments in 2023

Teaching Session	Topic	Assignment
1	Introduction to Microcontrollers	1
2	Digital Output	2
3	Digital Input	3
4	Interrupts, Timers, and LCD	4
5	Analog-to-Digital Conversion	5
6	Serial I/O	6

While the topics covered are essential, the time allocated to them appears insufficient to address the critical details comprehensively. For instance, teaching session 4 covers interrupts, timers, and LCDs. Each of these topics is extensive and significant enough to warrant its own dedicated session. Similarly, Analog-to-Digital Conversion (ADC), introduced in session 5, could benefit from being expanded into two teaching sessions. ADC is a fundamental concept in which measurable phenomena typically analog in nature are captured through transducers (sensors) and converted into digital signals for processing by digital devices. Expanding this topic would allow students to develop a deeper understanding of this crucial process.

In addition to insufficient time allocation, the current plan omits several important topics. While there is a session on digital output, the equally important concept of analog output is not addressed. For example, Pulse-Width Modulation (PWM) is an essential technique that enables digital devices to produce outputs resembling natural analog signals, which are more intuitive for users. Including this topic would enhance the curriculum by bridging the gap between digital and analog systems.

Another area that could be expanded is communication protocols. While Serial I/O is covered in session 6, introducing an additional protocol such as I2C would provide students with exposure to more sophisticated and widely used communication systems. This addition would deepen their understanding of the diverse communication protocols available in modern systems.

Lastly, the current plan includes only one session on the integration of microcontrollers with external devices, focusing on LCDs. Introducing an additional example involving other common devices, such as Servo Motors, would enhance students' practical understanding of microcontroller applications. Expanding this area would provide students with broader insights into real-world use cases and improve their ability to design versatile and practical solutions.

2.4 The Intervention (Proposed Changes)

The updated content of the teaching sessions and their accompanying assignments (course plan) is summarized in Table 2. This revised course plan was implemented in the spring semester of 2024. While

Table 2. Teaching sessions and their accompanied assignments in 2024

Teaching Session	Topic	Assignment
1	Introduction to Microcontrollers	1
2	Digital Output	
3	Digital Input	2
4	Interrupts	
5	Timers	3
6	Pulse-Width Modulation	
7	Analog-to-Digital Conversion I	4
8	Analog-to-Digital Conversion II	
9	Serial I/O	5
10	I2C	
11	Driving Servo Motors	6
12	LCD	

the number of teaching sessions has doubled compared to the previous plan (Table 1), the number of assignments has remained unchanged. However, the assignments were designed to require knowledge from at least two different teaching sessions. This approach ensures that students not only build their

competencies in specific topics but also develop an understanding of how these topics interconnect. The addition of six more teaching sessions reduced the time allocated for the self-selected individual project from fifteen weeks to six weeks. Despite this reduction, the stronger foundation provided by the additional teaching sessions more than compensated for the shortened project duration. The enhanced preparation allowed students to complete more challenging projects within the six weeks, using appropriate methods and demonstrating higher-quality outcomes than before.
Furthermore, during the six-week project period, students were required to consult with the course instructor at three distinct stages of their project. These consultations ensured that the projects met the required level of challenge and quality. This iterative review process not only provided guidance but also fostered a consistent focus on achieving high standards in project implementation.

2.5 Evaluation Method

The evaluation of the implemented measures was conducted using two primary methods: the analysis of project evaluation results and feedback collected from students. Significant improvement in project outcomes would serve as the strongest indicator that the implemented changes had a positive impact. However, it is important to acknowledge that several other factors could influence the results, such as the quality of the students, their attitude toward the subject, their understanding of prerequisite courses, and even the workload from other courses. These variables could have a considerable impact on the quality of the projects and, consequently, on their evaluation results. To mitigate the influence of these confounding factors, a long-term observation of results before and after the implementation of the proposed measures should be conducted to establish more robust conclusions.
Student feedback was collected through the reference group and normal course evaluation procedures. Two specific survey questions, asked both before and after the changes were implemented, were particularly insightful in this context:

A. Which learning activities used in the course have given you the greatest learning benefit?
B. To what extent did you experience that the general workload in this subject corresponded to the learning outcome descriptions and the number of credits?

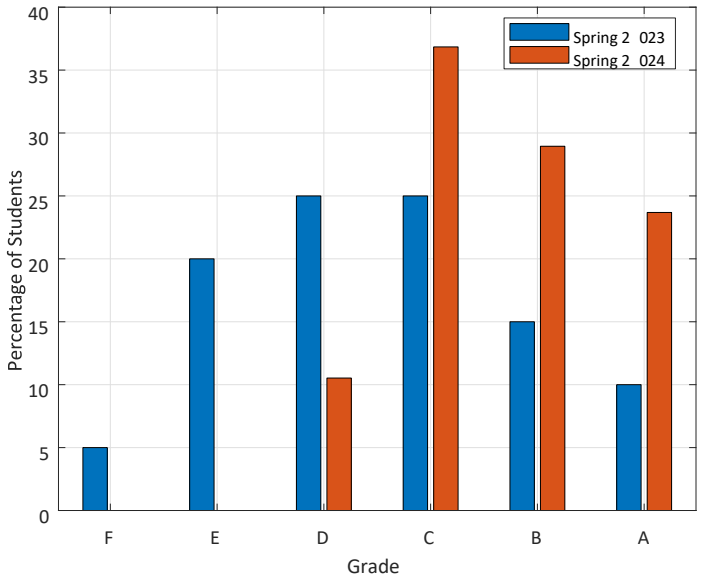


Fig. 1. Comparison of projects' evaluation results between spring 2023 and spring 2024.

The answers to Question A were intended to indicate whether the teaching sessions, along with their accompanying assignments, provided sufficient knowledge to enhance self-learning. Meanwhile, the answers to Question B shed light on how manageable the self-learning process was for students. A negative correlation between these two questions was anticipated; students finding the workload too demanding might report lower benefits from the learning activities.
In addition to the standard questions, the following were added to the survey form used after the implementation of the proposed changes:

C. Did the teaching sessions give you confidence to undertake challenging projects?

D. Did the teaching sessions make it easier to learn on your own?
E. During the implementation phase of your project
   (i). Did you self-learn anything new?
   (ii). What did you teach yourself?

These questions aimed to determine whether the teaching sessions provided a sufficient foundation of knowledge to support students' self-learning. They also sought to explore the influence of the sessions and accompanying assignments on the types of projects students chose to undertake.
Students were asked to respond to Questions A, B, C, and D by indicating the extent to which they agreed with the statements, using a five-point scale: "agree to a very large extent," "a large extent," "a medium extent," "a small extent," and "a very small extent." For Question E(i), students answered "yes" or "no," while those who selected "yes" were invited to elaborate on their response to Question E(ii) in their own words.

3. Results

The results obtained from the discussed evaluation methods are presented in this section. The results are divided into project evaluation, survey questions before and after the implemented measures, and additional survey questions.

3.1 Project Evaluation

Significant improvements were observed in the submitted projects after the implementation of the proposed measures, particularly in terms of the challenges addressed by the projects and the methods students used to overcome these challenges. This improvement is reflected in the grades students received during project evaluation. The evaluation for the semester in question (spring 2024) was conducted by the same two examiners as in the previous year (spring 2023), ensuring consistency in grading standards.
A comparison of the results between the two semesters is presented in Fig. 1. While only a quarter of the students achieved a grade of B or higher in 2023, more than half of the students attained these grades in 2024. The improvement is even more pronounced at the lower end of the grade scale, where only 10% of students received a grade of D in 2024, with no students receiving grades lower than D. This is in stark contrast to the results from 2023, where half of the students were graded at D or lower.

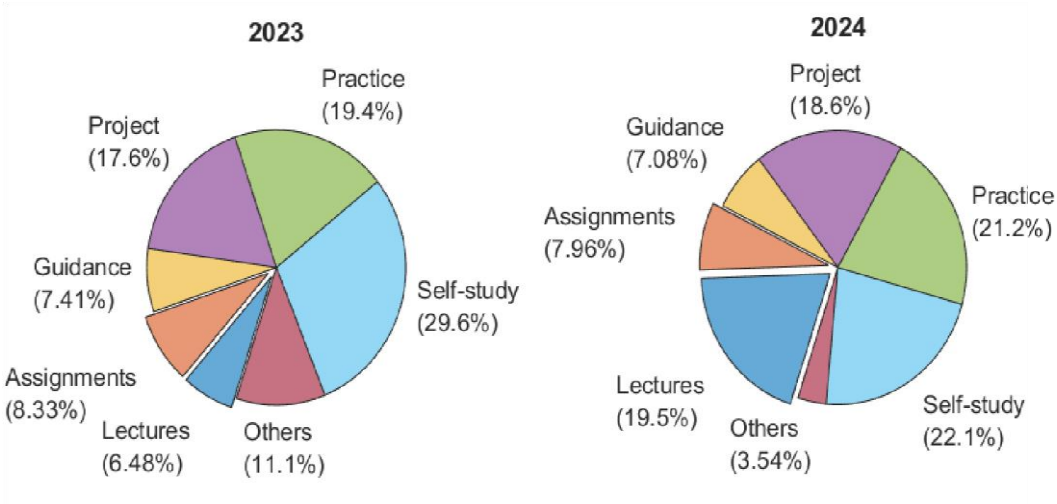


Fig. 2. Summary of the answers to the question "which learning activities used in the course have given you the greatest learning benefit?"

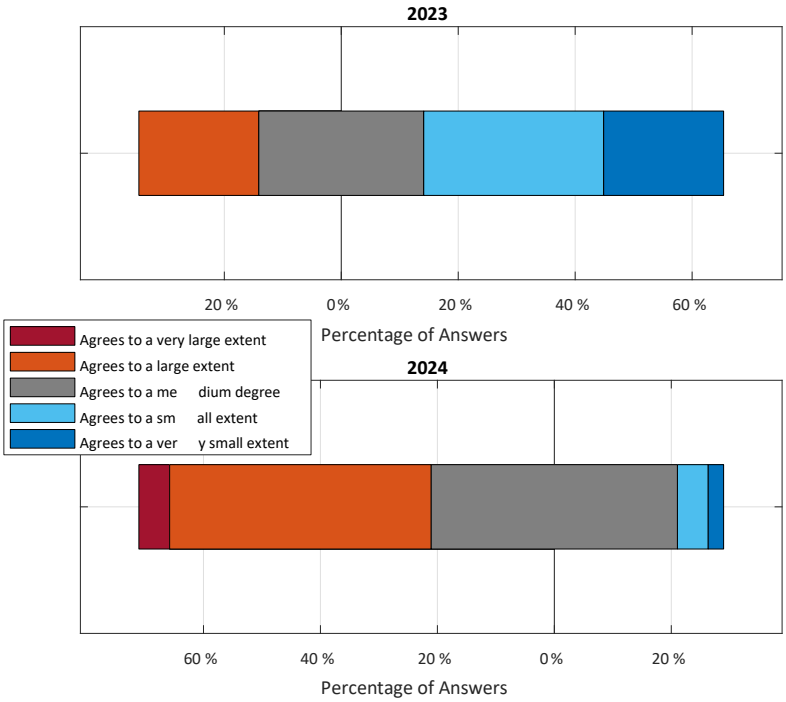


Fig. 3. Summary of the answers to the question "To what extent did you experience that the general workload in this subject has corresponded to the learning outcome descriptions and the number of credits?"

3.2 Comparable Survey Questions

We can further compare the results by analyzing the answers to Questions A, "which learning activities used in the course have given you the greatest learning benefit?" from 2024 and those provided in 2023. As shown in Fig. 2, the percentage of students selecting lectures as the activity that provided them with the greatest learning benefit increased threefold, rising from 6.5% in 2023 to 19.5% in 2024. This significant change suggests that the teaching sessions are now successfully fulfilling their intended purpose of providing fundamental knowledge of the subject.

To evaluate whether the teaching sessions facilitated self-learning and reduced the perceived workload of the course, we compared students' responses to Question B, "To what extent did you experience that the general workload in this subject has corresponded to the learning outcome descriptions and the number of credits?" from 2023 and 2024. As illustrated in Fig. 3, the percentage of students who considered the workload too heavy decreased by more than half, from 65% in 2023 to 30% in 2024. Notably, self-study continued to be identified by many students (Fig. 2) as the activity that provided the greatest learning benefit. These results imply that the reduced perception of workload is not due to a decrease in self-learning but rather because students are now engaging in self-learning more efficiently.

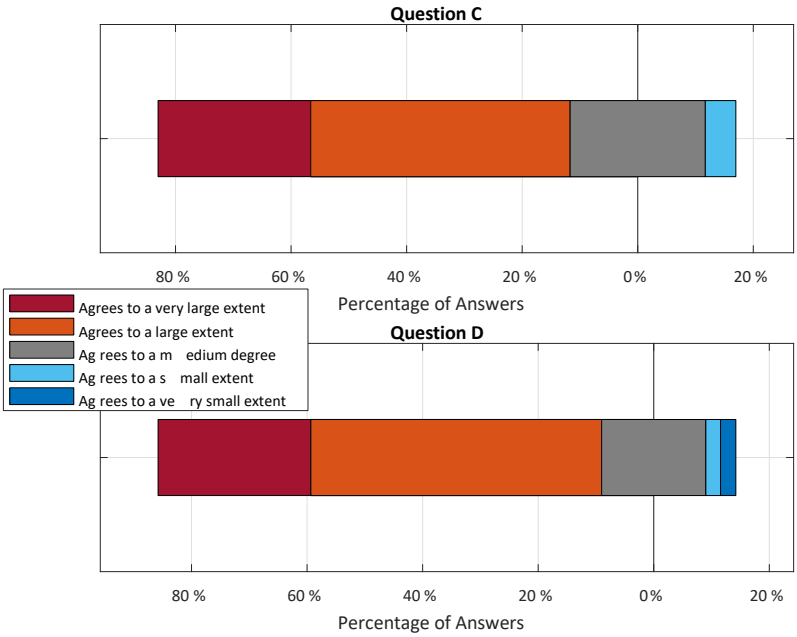


Fig. 4. Summary of the answers to Question C, "Did the teaching sessions give you confidence to undertake challenging projects?", and Question D, "Did the teaching sessions made it easier to learn on your own?".

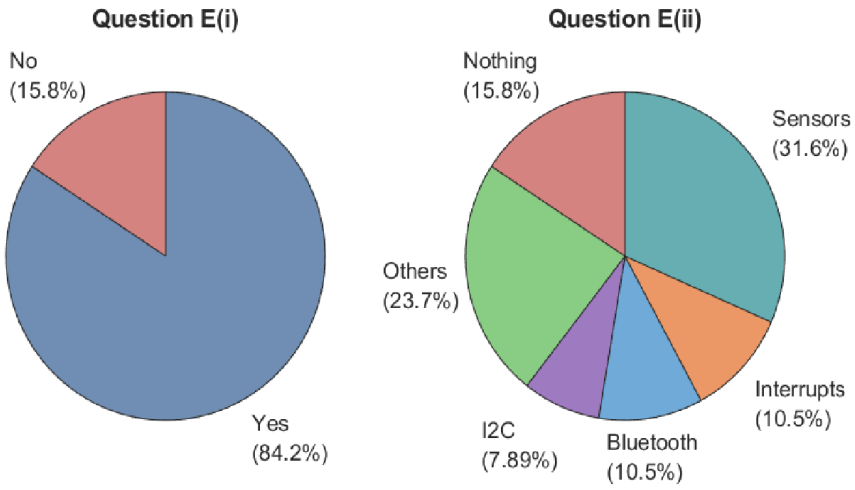


Fig. 5. Summary of the answer to Question E(i) "Did you self-learn anything new during the implementation phase of your project?" and Question E(ii) "What did you teach yourself?".

3.3 Additional Survey Questions

The students' responses to the additional questions (Questions C, D, and E) provide even clearer evidence that the implemented changes achieved their intended outcomes. The responses to Question C, "Did the teaching sessions give you confidence to undertake challenging projects?", and Question D, "Did the teaching sessions made it easier to learn on your own?" are summarized in Fig. 4. The figure shows that over 80% of students believed the teaching sessions significantly contributed to building their confidence to undertake challenging projects, with more than a quarter indicating that the sessions achieved this to a very large extent. Similarly, approximately 85% of students agreed that the teaching sessions provided the fundamental knowledge needed to facilitate self-learning, with more than a quarter stating this was achieved to a very large degree.

Lastly, the responses to Question E(i), "Did you self-learn anything new during the implementation of your project?", and the topics students self-learned during the project phase are summarized in Fig. 5. Approximately 16% of students indicated that the teaching sessions and accompanying assignments

alone were sufficient to complete their projects. However, 84% of students reported learning additional material independently to successfully complete their projects. This latter finding suggests that a significant portion of students had the confidence to undertake more challenging projects that extended beyond the topics covered in the teaching sessions or assignments. Nearly a third of the students (31.6%) learned how to integrate sensors not covered in the teaching sessions with the microcontroller, gaining practical experience in reading and interpreting device datasheets. Communication protocols were another common area of independent learning, with 10.5% of students learning and using the Bluetooth protocol and 7.89% expanding their knowledge of the I2C protocol. Another notable topic was Interrupts, where 10.5% of students deepened their understanding and skills beyond what was taught in the sessions. These findings demonstrate that the teaching sessions, along with their accompanying assignments, effectively covered the fundamental concepts necessary to complete basic projects. Moreover, they provided an excellent foundation for self-learning and built the confidence needed to undertake more complex and challenging projects. This balance between guided instruction and independent exploration underscores the effectiveness of the implemented changes in enhancing both foundational knowledge and students' ability to expand their learning independently.

3.4 Interpretation of the Results

The findings of this study affirm that strengthening fundamental knowledge through increased teaching sessions bolsters student confidence, skill acquisition, and self-directed learning, which are key factors that facilitate better project performance. Recent literature emphasizes that foundational topics must be thoroughly covered in engineering education, especially in project-based courses, due to the hierarchical nature of technical knowledge [14]. Although PBL fosters creativity, collaboration, and real-world problem-solving, it can be undermined if students lack the core concepts necessary to navigate more advanced tasks. In the present study, the extended instructional sessions helped solidify foundational principles, thereby allowing students to approach projects with greater competence and confidence. As [13] suggest, while PBL thrives on hands-on engagement, structured teaching and well-placed assignments provide the essential scaffolding for meaningful application of theory.

Notably, the allocation of project implementation time was reduced from 15 to 6 weeks, yet the quality of student projects improved significantly. This counterintuitive outcome underscores how instructional design outweighs mere project duration [15, 16]. By dedicating additional time to guided instruction, students acquired a deeper conceptual understanding and encountered fewer obstacles during project work. This aligns with [17] view that inductive teaching strategies succeed when learners possess sufficient background knowledge to build upon. The enhanced confidence students reported also ties closely to self-efficacy theory, which posits that mastery experiences and adequate support increase one's belief in their capabilities [11, 12]. Thus, while the total project window was compressed, students' self-assurance and newly honed skills enabled them to work more efficiently, ultimately producing stronger outcomes.

4. Conclusion

This study investigated the impact of increasing teaching sessions from six to twelve in a first-year Computer Architecture course that employs a PBL framework. The results emphasize the importance of integrating fundamental instruction into PBL-oriented courses. The hierarchical nature of engineering knowledge necessitates that students develop a robust understanding of foundational topics before engaging in advanced, application-driven tasks. The intervention demonstrated that well-structured teaching sessions not only enhance technical proficiency but also reduce cognitive load, enabling students to work more efficiently during project implementation. This was particularly evident as project duration was reduced from 15 to 6 weeks without compromising the quality of project outcomes. Moreover, the study highlighted the role of guided tasks and active learning strategies in fostering student engagement and confidence. By moving beyond traditional lecture formats, the additional teaching sessions provided opportunities for hands-on exercises, collaborative problem-solving, and real-time feedback. These elements proved critical in equipping students with the skills and mindset needed for independent exploration and lifelong learning.

While the findings are promising, the study is not without limitations. The small sample size, lack of long-term observation, and potential influence of external factors such as student quality, workload, and prerequisite knowledge warrant caution in generalizing the results. Future research should address these limitations by employing larger sample sizes, longitudinal designs, and more comprehensive control of confounding variables to validate and extend these findings. However, this study contributes

to the growing body of evidence supporting the integration of foundational instruction with project-based methodologies. It provides actionable insights for educators seeking to optimize course structures to enhance learning outcomes, particularly in technical disciplines. Educators can empower students to excel in both their academic and professional pursuits by prioritizing fundamentals, incorporating guided tasks, and creating supportive learning environments. These findings underline the critical role of instructional design in fostering student success, particularly in the early stages of engineering education.

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Learning through Lived Roles: Personas as Pedagogical Anchors in Online Higher Education

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Abstract

Effective online learning environments situate abstract concepts within authentic, human-centered contexts that promote relevance, application, and deeper learner engagement. Personas support this process by helping learners engage with realistic human situations that make course concepts more concrete and relatable while fostering emotional and cognitive connections to the material. The use of personas in online higher education is informed by established pedagogical theories, including situated learning, cognitive load theory, and social presence frameworks. From a sociocultural perspective, learning is shaped through interaction with meaningful contexts and tools [11], and personas support this process by embedding course content within realistic scenarios. Situated learning further emphasizes that knowledge is inseparable from the social and professional contexts in which it is applied [5]; personas model these environments through representative roles, challenges, and decision-making processes. Personas also align with cognitive load theory by providing narrative coherence that helps learners organize information and reduce extraneous cognitive processing, particularly for novice learners [10]. In online environments, personas can further enhance social presence, a core element of the Community of Inquiry framework associated with learner engagement and perceived relevance [2]. By humanizing instructional content, personas help reduce the psychological distance often inherent in online learning [9].

Across text-, image-, and video-based materials, personas anchor abstract concepts in realistic contexts and make disciplinary thinking visible. Visual and narrative representations can support comprehension, ethical reasoning, and problem solving across disciplines such as business, engineering, public policy, and the social sciences. Video-based personas extend these benefits by modeling professional reasoning through voice, expression, and storytelling. Research on multimedia learning suggests that well-designed combinations of visual and auditory cues enhance comprehension and retention when aligned with evidence-based principles [7]. Interactive AI chatbot interactions further extend persona-based learning by enabling dialogue, practice, and formative feedback at scale [6], [13], [14]. These low-stakes interactions allow learners to explore ideas, rehearse skills, and receive immediate responses while iteratively refining their understanding. AI chatbot personas may also support student-centered learning and accessibility through personalized pacing and just-in-time support [6], [14]. Looking forward, AI avatars may blur the boundaries between instructional content, simulation, and human interaction by enabling learners to engage with intelligent digital characters that model professional reasoning, communication, and decision-making in authentic contexts. However, regardless of the modality through which they are implemented, the strategic use of personas and AI-driven interactions has the potential to humanize online learning, deepen learner engagement, and support authentic knowledge transfer in higher education.

Keywords: *Situated learning, Theory to practice, AI experiential learning, Engagement in Online Learning*

Introduction

Online higher education continues to expand, yet persistent challenges remain regarding student engagement, perceived relevance, and authentic transfer of learning [1]. While technological innovation often dominates discussions of digital pedagogy, engagement in online environments is shaped less by the tools themselves than by how instructional design situates learning in meaningful human contexts, supports cognitive organization, and fosters social presence [2].

Personas—deliberately constructed representations of people in defined professional, social, or disciplinary roles, used to embed course content within an authentic human context—offer a scalable, research-informed strategy for strengthening engagement across modalities. Whether implemented through simple written narratives, recurring case studies, animated video scenarios, AI-driven

conversational agents, or AI avatars, personas function as pedagogical anchors that connect abstract disciplinary concepts to authentic professional and social contexts.
Persona-based learning draws on a well-established set of theoretical foundations—situated learning [5], sociocultural theory [11], cognitive load theory [10], and the Community of Inquiry framework [2]—each of which is examined in greater depth in the next section. Together, these perspectives suggest that engagement depends on situating content in authentic contexts, organizing information for cognitive coherence, and sustaining social presence. Emerging multimedia and AI technologies extend these possibilities [6], [7], [13], but the underlying mechanisms remain consistent across modalities. As a result, personas function as a scalable engagement strategy—effective in low-tech narrative formats and equally powerful when extended through multimedia or AI-driven systems.

Personas as Engagement Framework

In online learning environments, engagement depends less on technological sophistication and more on the extent to which learners experience relevance, social presence, and cognitive coherence across instructional contexts [1], [2]. Engagement emerges from how personas structure meaning-making, reduce abstraction, and model disciplinary thinking — not from the technological complexity of the implementation.
Beyond contextualizing content, personas can be understood as an engagement framework that structures how learners attend to, interpret, and act on disciplinary knowledge. From an instructional design perspective, personas function as representational tools that narrow interpretive possibilities and highlight relevant cues within complex learning tasks. In this sense, they operate as instructional constraint systems that reduce ambiguity and guide decision-making through defined roles, goals, and contextual boundaries. Personas also shape how learners interpret problems, evaluate information, and apply disciplinary ways of thinking within situated scenarios (much like the context faculty provide in person). This emphasis on contextually grounded, role-based activity aligns with research on authentic learning environments, which highlights real-world relevance, complex problem contexts, and sustained engagement with disciplinary practices [3]. This framing supports not only comprehension but also professional judgment, as learners engage in repeated cycles of perspective-taking and problem-solving from a defined role. Importantly, personas provide opportunities for identity rehearsal, allowing learners to practice disciplinary ways of thinking in low-stakes environments that approximate real-world complexity without its associated consequences [12]. In this way, personas extend beyond engagement facilitation to function as scalable pedagogical structures that integrate attention management, meaning-making, and professional reasoning within online learning environments.
At a low-tech level, persona design may take the form of structured narrative briefs with images, reflective case logs, or sequential scenario updates that revisit the same persona across instructional units. At higher levels of technological integration, personas may be extended through video-based simulations, branching multimedia narratives, or interactive AI dialogue systems that allow learners to interrogate, advise, and reason through unfolding professional situations. (See Fig. 1.)

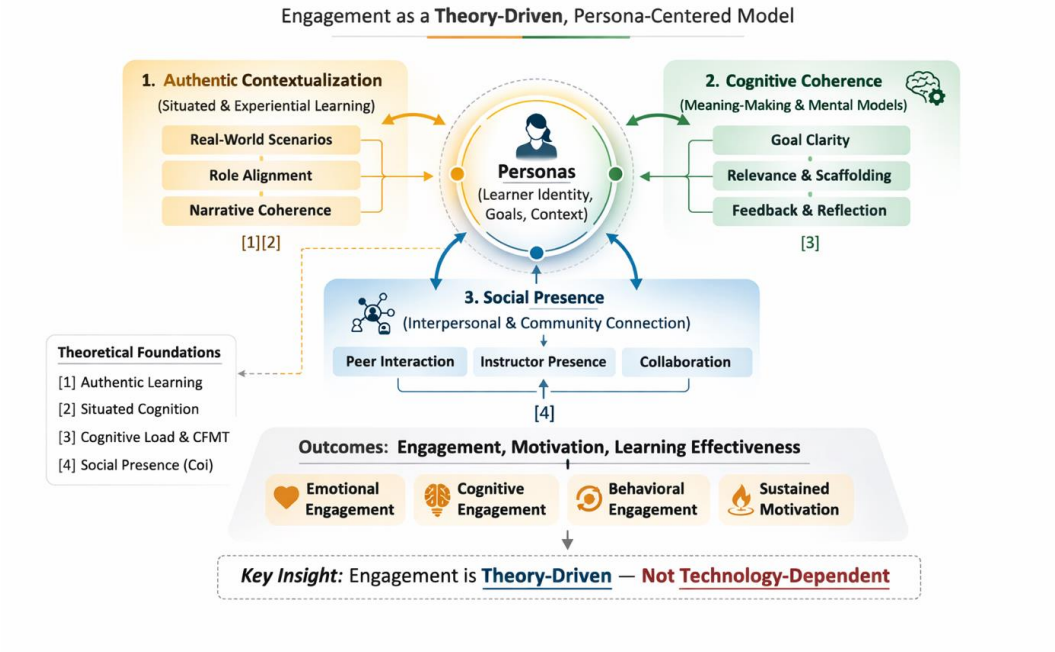


Fig. 1. Persona-Based Engagement Across Theoretical Frameworks
The model highlights how persona design draws on theory to create relevance, coherence, and social presence across modalities.

Personas in Practice

The following examples illustrate how persona-based design operates across a range of disciplines and modalities. Rather than cataloging implementations, the cases are organized around four theoretical lenses — situated learning, cognitive load and narrative coherence, multimedia design, and social and teaching presence — that each surface a different engagement mechanism. Together they show how the same underlying framework adapts to varied disciplinary contexts and levels of technological complexity.

Situated Learning and Disciplinary Role-Taking

Situated learning theory emphasizes that knowledge is inseparable from the contexts in which it is applied [5], while sociocultural perspectives highlight that learning is mediated through social interaction and cultural tools [11]. Within this combined framework, personas function as instructional mediators that translate abstract disciplinary concepts into situated activity systems in which learners take on defined professional roles, navigate contextual constraints, and make decisions under conditions of uncertainty.

In an undergraduate management survey course, for example, seven personas were developed to represent the majors most heavily enrolled in the course, including hospitality management, public relations, health services administration, apparel merchandising, building science, wildlife enterprise management, and aviation management. Because the course serves primarily non-business majors, many students enter without a clear sense of how management theory applies to their intended careers. Each persona occupies a distinct management level and industry context, and course activities use these characters to ground theoretical frameworks such as Value, Rarity, Imitability, Organization (VRIO) analysis and Porter's Five Forces in scenarios students can recognize as relevant to their own professional trajectories. Rather than asking students to bridge the gap between abstract management principles and their own fields, the personas do that translation as a structural feature of the course design.

Cognitive Load and Narrative Coherence

Cognitive load theory emphasizes the importance of reducing extraneous processing to optimize learning [10]. This principle informed the design of an online hospitality professional development course in which students are introduced to the concepts of career planning and preparation in the hospitality

industry. In this course, personas are used to provide context and relevant examples for four specific hospitality fields: Event Management, Culinary Science, Hotel Operations, and Restaurant Management. For each of the four fields, three personas are introduced and referenced throughout the course, representing an early-career position, a mid-career position, and an advanced career position. By providing industry-relevant examples and scenarios that represent potential career paths centered around these personas, the course design makes general professional development instruction specific for students in all four hospitality fields, reducing the extraneous processing required to connect general guidance to field-specific practice.

Personas can also provide narrative coherence by organizing information into structured, recurring contexts that support schema development [10]. An example of personas supporting narrative coherence comes from a graduate Brewing Science and Operations program course designed to bridge online coursework with real-world commercial brewing environments. To support this transition from theory to practice, an animated persona, a beer can character named “AU Brew,” functions as a consistent narrative guide throughout the course. Unlike the role-based personas in other examples, AU Brew does not represent a professional identity; instead, it functions as a narrative anchor for coherence and continuity across modules. This distinction illustrates that persona-based design encompasses both professional role representations and narrative guides, with each activating different aspects of the engagement framework.

AU Brew introduces the practicum by framing the purpose, scope, and expectations of the experience, emphasizing its grounding in cooperative education principles and its integration of academic learning with professional practice [4]. Through narration, AU Brew contextualizes the practicum as an opportunity for students to apply brewing science concepts in authentic settings, collaborate with faculty and industry partners, and engage with professional organizations such as the Brewers Association and commercial breweries. This framing establishes a coherent storyline that connects students’ prior online learning to their experiential work in the field. The persona provides a stable professional perspective that frames learning goals, situates expectations, and supports learners as they integrate classroom concepts into practical environments [4], [5]. This example demonstrates how animated personas can function as cognitive and contextual anchors, supporting coherence and relevance in online-to-experiential learning transitions.

Visual and Auditory Persona Design

Multimedia personas can further enhance germane processing when visual and auditory elements align with evidence-based design principles [7]. This informed the development of a special observation course in an online Speech, Language, and Hearing Sciences program. In this course, a consistent set of animated characters was used across modules to demonstrate course concepts such as target behaviors, goal writing, material selection, and data collection. By keeping the setting and characters consistent, the course design reduces the need for students to reorient to new contexts and supports schema construction by letting them observe how course concepts build on each other within a continuous clinical narrative. As the final course in the program, this narrative continuity also activates prior learning, giving students a framework to integrate and apply knowledge developed across earlier coursework. The animated scenarios further support this by asking students to make clinical decisions within a controlled, zero-stakes environment, allowing them to practice professional judgment without the pressures of a live clinical setting.

Social and Teaching Presence through Personas

Personas can also operationalize teaching presence — the instructor’s role in shaping discourse, guiding inquiry, and offering direct instruction [2]. In a master’s-level social work course, for example, a persona representing the instructor was embedded throughout the course. The course covers extensive historical context related to the evolution of mental health frameworks, and the instructor wanted a clear way to distinguish personal interpretations and contemporary reflections from the historical record itself. Using character animation software, the creative team (under the guidance of an instructional designer) created an animated character based on the instructor’s likeness and paired it with a custom, visually distinct callout box in the online course. This design choice signaled to students that these moments reflected the instructor’s interpretation rather than an objective historical narrative, giving the instructor a recurring, visible channel for interpretive commentary distinct from the historical record. The primary goal was to support critical thinking by helping students differentiate between historical accounts and scholarly interpretation while maintaining clarity and transparency in course content.

In addition to supporting cognition, personas can reduce the psychological distance that often characterizes online environments. Social presence is central to sustained engagement [2], [9], and personas humanize digital instruction by modeling voice, perspective, and lived experience. In a cross-disciplinary entry-level course on mass timber systems, students engage with interconnected industry personas representing key roles across the supply chain, spanning forest management through design and construction. This grant-funded course incorporates a mix of static and animated personas to bring content to life and provide context across the different disciplines to help ensure students have insights into each field of expertise. A forester, construction manager, architect, structural engineer, and landscape designer each approach shared course topics from their distinct disciplinary perspectives, spanning sustainability, construction, design, structural performance, and site integration. Importantly, these personas reappear across multiple learning modules rather than being limited to isolated case examples, allowing students to encounter each issue through different professional lenses over time. As students revisit course topics through these recurring perspectives, they begin to understand how disciplinary roles lead to different interpretations of the same design, construction, or environmental challenge. As a result, learners develop a deeper understanding of mass timber as an interconnected socio-technical process while also strengthening engagement through exposure to authentic, human-centered perspectives embedded throughout the course. This aligns with situated learning theory, which emphasizes that knowledge is developed through participation in socially and contextually grounded practices rather than through decontextualized content alone [5].

Engagement and Technical Complexity

The persona-based engagement framework demonstrates how instructional personas can be implemented across varying levels of technological complexity while maintaining consistent mechanisms. Rather than representing discrete or hierarchical modalities, the model reflects a continuum of design approaches that support learner engagement through structured social, cognitive, and contextual processes in online learning environments. (See Fig. 2.) Prior research in higher education online learning emphasizes that engagement is shaped more by instructional design, social presence, and cognitive presence than by technological sophistication alone [2]. This holds across AI-supported environments as well, where interaction design and narrative structure remain central to sustaining engagement [1].

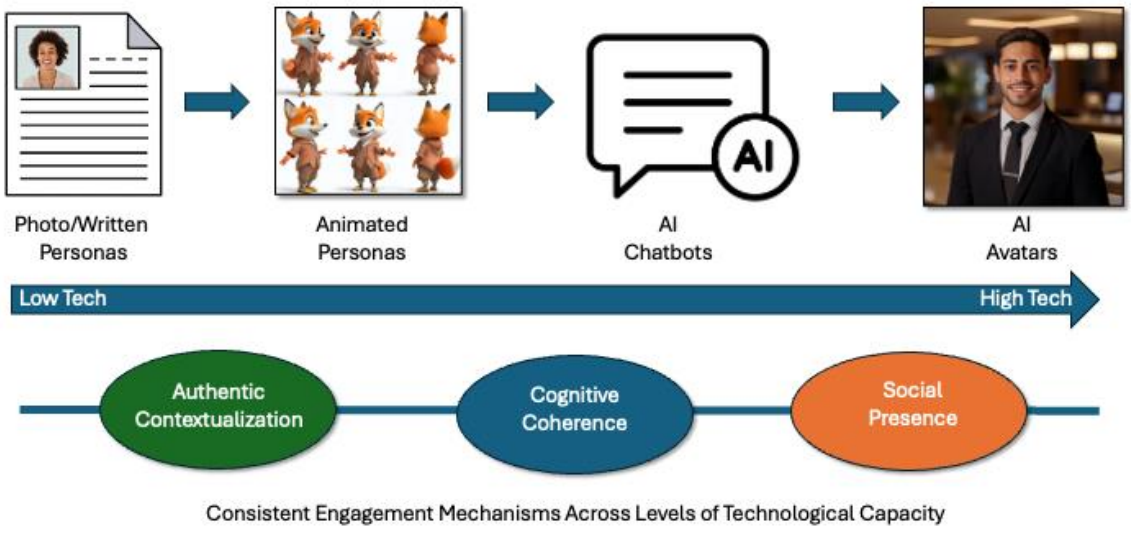


Fig. 2. Continuum from Written Personas to AI Avatars
The scenarios illustrate that personas can be implemented along a continuum of design approaches—from written narratives to AI-enabled avatars—while activating consistent pedagogical mechanisms.

At the lowest level, written narrative personas provide foundational contextualization by situating abstract concepts within relatable human scenarios, consistent with research showing that contextual grounding supports comprehension and meaning-making in online learning environments [3]. As implementation increases in complexity, recurring case-based personas supported by visuals enhance

narrative coherence and support schema development through sustained exposure to consistent characters and contexts [7], [10]. Instructor-recorded video personas extend this approach by modeling disciplinary reasoning and professional identity through voice, presence, and expressive communication, aligning with findings that instructor presence strengthens engagement and reduces psychological distance in online learning [9]. Interactive multimedia scenarios further enable applied decision-making by embedding learners in dynamic, branching environments that simulate authentic professional conditions, reflecting evidence that simulation-based and immersive learning environments enhance cognitive engagement and transfer [8]. At the highest level, AI chatbot personas support iterative dialogue and adaptive feedback, consistent with emerging research demonstrating that AI-mediated systems can enhance personalization, engagement, and formative learning support in higher education contexts [14]. Across all levels, engagement is driven by shared mechanisms of contextualization, cognitive organization, and applied reasoning, demonstrating that pedagogical effectiveness depends on consistent presence-driven instructional design rather than technological complexity alone. (See Table 1.)

Table 1. Scalable Engagement Model for Online Learning: Levels of Implementation

Level of Implementation	Technological Complexity	Engagement Mechanism
Written narrative	Low	Contextualization and relevance
Recurring case study with visuals	Low-Moderate	Narrative coherence and schema support
Instructor-recorded video	Moderate	Modeling reasoning and professional identity
Interactive multimedia scenario	Moderate-High	Applied decision-making
AI chatbot and avatar	High	Iterative dialogue and adaptive feedback

Future Directions

AI chatbots and avatars open new possibilities for course-specific persona implementation, extending social presence through adaptive dialogue and formative feedback [6], [13] and — in immersive learning environments — embodying personas as interactive avatars within extended reality (XR) experiences. For example, in an Occupational, Career, and Placement Services course, students evaluate the accessibility and appropriateness of real-world job sites for individuals with disabilities as part of their professional preparation. The XR experience is modeled after the Auburn University Human Resources (HR) department, allowing students to explore a simulated workplace environment they are likely to encounter in practice. Within this setting, a human-appearing avatar assumes the role of an HR manager, welcoming students to the space and responding to questions about the job position being evaluated. This humanoid avatar functions as an advanced persona within the framework, supporting situated learning through authentic context [5], reinforcing cognitive coherence by embedding evaluation tasks within a realistic narrative [10], and enhancing social presence through voice-based, interactive communication [2]. As illustrated in the framework matrix, this XR implementation demonstrates how advanced and AI-enabled personas can activate the same engagement mechanisms as lower-tech persona approaches while also expanding opportunities for interaction, immersion, and experiential practice [8].

Other implementations apply the same engagement mechanisms through conversational rather than embodied AI personas. For a hospitality management program, course designers are developing a virtual hotel concierge trained on video interviews of multiple hospitality professionals, capable of responding verbally to student questions through either a spoken or typed interface. Key segments of individual interviews will be used within a virtual tour of the Auburn University Hotel and Conference Center. The virtual concierge, however, will draw on the full content of these interviews, enabling it to respond to questions that span multiple departments, require comparison, or extend beyond what the tour clips cover.

Beyond traditional higher education, persona-based approaches are increasingly relevant in professional development contexts, where employees benefit from the same mechanisms of contextualization, cognitive organization, and social presence that support student learning. For example, in a workforce training program, an AI chatbot persona trained on facilitator rubrics and

exemplar submissions engages employees in structured dialogue as they develop professional program assessment plans, offering formative feedback on alignment, clarity, and completeness before formal facilitator review [6], [13]. As AI-generated personas become increasingly lifelike in voice, expression, and responsiveness, the boundary between human and digital interaction will continue to narrow across professional development and traditional learning environments, raising both the potential for deeper engagement and new considerations around transparency, trust, and ethical design.

Conclusion

The effectiveness of personas depends on pedagogical intentionality, not on delivery modality. Across the examples in this paper — from a written persona in an undergraduate management course to an XR avatar in an HR simulation — the same engagement mechanisms recur: authentic contextualization [3], [5], cognitive organization through narrative structure [10], perspective-taking across disciplinary roles [12], and multimodal alignment that reinforces a consistent persona-driven narrative [7]. AI extends what is possible at the high end of the continuum but does not alter the underlying theory [6]; the engagement work is done by the design, not the technology.

As persona-based approaches expand into professional development and workplace learning, these principles hold. What changes is the design challenge: as AI-driven personas become increasingly lifelike, instructional designers will need to address transparency, trust, and ethical intentionality with the same care they bring to pedagogical alignment. The line between human and digital interaction will continue to narrow; the underlying pedagogy does not have to.

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Gamifying Feedback for Student Engagement in Research Modules: A Design-Based Research Approach

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Abstract

Designing engaging learning experiences present new challenges especially in contexts where generative AI can be used to complete academic work. This is particularly concerning in research modules where most assessments are text based. Furthermore, providing detailed feedback on informal activities can unintentionally result in students disengaging. They may use the feedback as prescriptive instructions for formal assessments as opposed to actively engaging and interacting with the lecturer and their peers as part of the learning process. This study presents the design and first implementation of a series of activities grounded in experiential learning to gamify feedback in research modules. A Design Based Research approach was adopted to develop and create an artefact by positioning the educator as designer and implementer. Data to refine the artefact was generated by means of expert critique and a structured reflection organizer informed by experiential learning theory and gamification design principles. The findings provide insight into the design process and design choices made to create the artefact aimed at gamifying feedback in research related modules. This study contributes to investigations into practical approaches to possibly improve student engagement and assign value to human interaction and engagement in the learning process.

Keywords: *Gamification, Research Modules, Feedback, Reflective Design*

1. Introduction

A challenge that many Higher Education lecturers face is sustained student engagement [1], [2]. There are two factors that make student engagement especially challenging in research modules where most assessments are text-based and submissions are iterative in nature [3]. The first is Generative Artificial Intelligence (GAI) because students can easily outsource their thinking and work without truly engaging in the learning process [4]. The second is lecturer feedback, not only is it possible that feedback is provided on GAI text with limited to no student engagement, but students may also use the feedback as prescriptive instructions for formal assessments as opposed to actively engaging with the lecturer and their peers during the iterative research process. Gamification of educational content has been found to increase student engagement of which one strategy is using rewards to recognise student effort [1]. This study specifically focussed on designing an artefact to gamify feedback in research modules by rewarding and recognising student engagement. Li et al. [1] explain that developing and implementing gamification could be complicated and suggest that the game mechanics, elements, and structure first be established before including subjective aspects like player experience. Thus, this study was exploratory in nature and focused on developing an artefact to address student engagement in research modules through reflection and expert critique which could be used for formal testing.

2. Design Based Research

Design based research (DBR) is a methodological approach that is systematic and flexible, with the intention to improve current practice by designing interventions to solve real world problems [5], [6]. Characteristics of DBR include grounding in pedagogical theory, considering context, iteratively analysing, designing, implementing, integrating different methods, and practical solutions [5]. During the process the researcher is responsible for systematically designing and implementing interventions to determine how the design could work and why [6]. In DBR the researcher holds multiple identities which ensure an in-depth understanding of the design and process [7]. In this study, the researcher was the lecturer, designer, and implementer. Different authors suggest variations on the phases of DBR, in this study the phases identified by McKenney and Reeves [8] were applied. The three phases include analysis and exploration, design and construction, and evaluation and reflection, which are revisited

regularly throughout the design process [8]. McKenny and Reeves [6] discuss two types of evaluation, formative and summative, as well as three types of testing, alpha, beta, and gamma. For the purposes of this study, only formative evaluation and alpha and beta testing were applied. The reason is that summative evaluation and gamma testing focus on assessing and testing a highly stable version of the artefact [6] whereas this study focused on the initial development and first implementation. Thus, for formative evaluation, one explores how the design could be improved [6]. Alpha testing concerns the logic of the design and its internal structures to determine the artefact's soundness and feasibility [6]. Beta testing considers its use in context without formally testing it [6]. The formative evaluation and alpha testing were done through developer screening, the researcher's reflective notes, and expert appraisal, individual expert critique, and feedback [6]. The reflection was guided by a structured reflective organizer which was informed by Experiential Learning (EL) theory and gamification principles. It also included four perspectives: lecturer, designer, implementer, and researcher. As recommended by McKenney and Reeves [6] the researcher engaged in a social reflective process with the experts but also more importantly solitary reflection regarding the artefact's meaning and application. Figure 1 illustrates a summary of the process followed in this study.

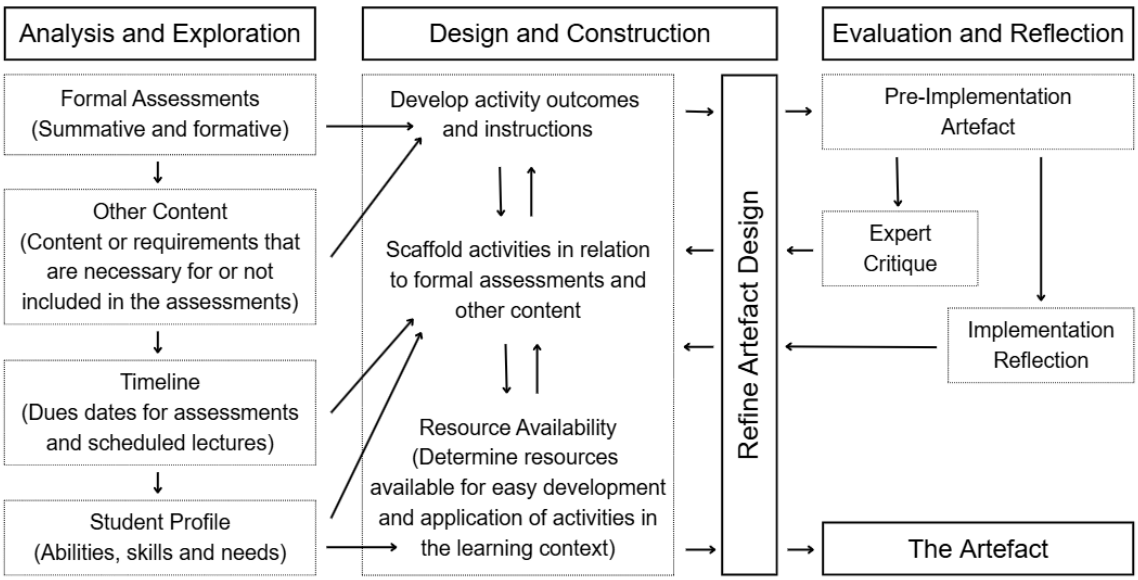


Fig. 1 The Design Process

What is not evident in Figure 1 but necessary to mention is the selection of a pedagogical approach before the research commences [5]. In this study, the pedagogical approach was EL, which was further supported by gamification principles. In the remainder of this article, the theoretical grounding will be discussed as well as each phase illustrated above and finally the artefact that this process yielded.

3. Theoretical Grounding

EL and Gamification formed the theoretical grounding that guided this study in the design process and during reflection. For EL theory the philosophical understanding of John Dewey is discussed as it has a stronger focus on the educator's role in planning and developing educational experiences. Gamification principles are also briefly addressed together with which were applied in the artefact.

3.1 Experiential Learning

John Dewey, the foundational philosopher of EL, argues that true and valuable learning occurs when students are actively engaged and involved in their environment, encounter obstacles, and reflect on outcomes [9]. Knowledge and skills are developed and applied through direct and meaningful experiences where interactions are planned and facilitated by an educator [10]. It is necessary to note that the experience on its own is not enough to guarantee learning, it requires structure and reflection to ensure its educational value [9]. Experiences could also be mis-educative if they do not provide a platform for further growth and learning or do not meet the required learning outcomes [11]. Dewey

suggests two principles for evaluating experiences: continuity and interaction [9]. Continuity relates to the conditions the experience creates to inform and affect the quality of future experiences for further growth and learning [11]. Interaction involves how the students' internal needs, desires, and capacities, and the external environment shape their experiences [9], [11]. Thus, the educator needs to know the context where the learning objective needs to be achieved as well as how it should be scaffolded for continuous learning [9].
In this study EL theory was the pedagogical approach used to develop scaffolded activities. One of the key components of EL is an educator who is knowledgeable in the subject matter as well as the students' readiness [12]. This is to ensure that the experiences are within the students' capabilities but also relevant to the module content [12]. Firstly, the researcher-designer, who is also the lecturer for the research module, considered the students' knowledge at every given point in the scaffolded process based on her previous experiences. In this way, she was able to ensure the continuity of the activities by designing it so that one learning experience informs, builds towards, and affects future experiences. Secondly, the researcher-designer's knowledge of the general student in these modules assisted with designing relevant activities. Understanding where the students should be in the research process and what they would need to continue to the next part, informed how the experiences were designed to ensure optimal progression. EL further informed some of the structured reflective organizer elements, these were learning outcomes, continuity, interaction, lecturer role, learning mechanics, intended experience, and enacted experience. EL also allows room for adapting experiences to ensure that the desired outcomes are reached, any such instances during the design process and reflection were noted by the researcher during the artefact development.

3.2 Gamification Principles

Gamification is the strategic use of game design elements, mechanics, and principles in non-game environments, like classrooms [14], [15]. The intention of gamifying educational content is to motivate students to achieve learning outcomes and increase engagement during their learning journey [15], [16]. The fundamental components that make games fun include game mechanics (non-player characters, points, turns, rewards, avatars, levels, badges, challenges/quests, leaderboards), learning mechanics (task, demonstration, educational tutorial, assessment feedback, reflect/discuss), and game aesthetics (narrative, sensation, audio, fantasy, challenge, fellowship) [14], [15]. Students generally find gamified educational content more engaging, and most studies conclude that it has an overall positive effect on the learning experience [1], [2], [15], [16], [17]. Gamification is more likely to be effective when the experiences are designed to meet students' needs and expectations [17] which relates to EL as a pedagogical approach. With regards to the educator, their willingness and skills, and the resource requirements to use the gamified elements, impact the application and implementation in the classroom [15].
In this study, rewards were used as the main game mechanic, tasks, discussion and reflection the learning mechanics, and challenge the game aesthetic. Students were rewarded with tokens for engaging with the content when posting ideas on a discussion board and then discussing it in class to 'buy' deeper levels of feedback. One could consider openly sharing research ideas with peers as the challenge aspect. Furthermore, games generally have rules and actors who attempt to achieve a goal by obeying the rules [16]. In this study, the 'rules' are the scaffolded instructions and experiences that students, actors, must complete to progress through their learning journey. Triantafyllou et al. [17] state that gamification can encourage both intrinsic and extrinsic motivation. For the most part the artefact in this study relied on extrinsic motivation that was driven by rewards for engagement. This relates most to what Triantafyllou et al. [17] call 'missions' and 'virtual goods' where students have certain goals for which they receive rewards. Since the researcher-designer is also the lecturer, the educator's willingness and ease of use was not a challenge, and resource availability was considered during the design to ensure easy implementation.

4. Analysis and Exploration

There were four distinct aspects analysed and explored to design the artefact: formal assessments, other content, timelines, and student profile. Each element in this phase was considered individually and in order from top to bottom as indicated in Figure 1. First the formal assessments, this included summative and formative assessments which have an impact on a student's final grade, these were considered to establish the milestones and final requirements of the module. In this specific case a Research Proposal was the summative assessment, and a concept document, literature review, and

ethics application the formatives. Thereafter, other content and requirements were considered which students must complete but are not included in the formal assessments. In the research modules where the first implementation took place, this was mostly focused on the memorandum of understanding that a student and supervisor must sign. The next important aspect was the timeline; this was impacted by the due dates for the formal assessments and the frequency and number of lectures scheduled. Lastly, students' abilities, skills, and needs were also considered from the researcher-lecturer's experience. Generally, the students' research abilities and skills are very limited, previous cohorts have differed slightly but usually one would need to start with the basics. Regarding needs, the students usually want the fastest route and only later realize that working consistently throughout the semester is required. The aspects of the research process that students tend to struggle with most include committing to a topic and focus, ensuring the study is feasible and valuing and applying feedback. The analysis and exploration of these aspects during the initial phase of the study informed the choices made during design and construction.

5. Design and Construction

There were three main considerations related to the design and construction: the activity outcomes and instructions, activity scaffolding, and resources availability. These considerations impacted one another during artefact development. Initially the activity outcomes and instructions were considered, and this was based specifically on the formal assessments and other content. While these activities were developed the options for scaffolding were explored and informed by the timeline and student profile. In this specific study the available resources were not considered during the first phase, analysis and exploration, but rather after there was a basic idea of the scaffolded activities and what would be required. This was to decide whether the available learning management system (LMS) could be used or if external tools should be considered. After exploring some external tools, it was decided to develop the artefact in the available LMS to ensure ease of management and support. For the students and lecturer, it meant that all academic work and activities are in one place and for the lecturer if any challenges arose there was support available on campus. For this specific artefact the discussion board tool as well as file submissions were used for the submission of work and the grade book with formula columns were used for managing rewards. Students would receive feedback tokens if they participated and submitted the required work. For some of the token activities it was necessary for students to discuss their thoughts and ideas in class to receive the maximum tokens available. Tokens were awarded by allocating marks for submissions and participation in class discussions and could be exchanged for deeper levels of feedback on formative assessments. The number of tokens received and used were captured in the gradebook where a formula calculated the remaining tokens per student. This yielded the pre-implementation artefact that was discussed with the experts in the evaluation and reflection phase.

6. Evaluation and Reflection

The evaluation and reflection phase included expert critique on the pre-implementation artefact and reflection by the researcher during the entire research process. Ethical clearance was obtained from the researcher and experts' institution before discussions started. The experts were purposefully chosen and recruited to participate in an in-person discussion of the design and included lecturers who taught similar research modules. These discussions were recorded, transcribed, and notes were taken by the researcher. This is considered data collected for artefact refinement. The researcher, who is also the lecturer, designer and implementer, kept reflective notes throughout the entire process. The reflective notes were structured according to a structured reflection organiser that was created using EL and Gamification principles. These reflective notes are also seen as data that was collected to refine the artefact. After receiving the expert feedback and during implementation the artefact was refined by going back to the design and construction phase. Expert critique included suggestions to scaffold some activities differently, incorporate visual and aesthetically pleasing elements and considering alternatives for token calculation. Reflection also yielded additional possibilities regarding the use of badges, levels, quests and leaderboards. The artefact was refined and adapted based on the expert critique and reflection, but major changes did not form part of the first implementation as to not confuse students during the semester. Changes that were made during the first implementation included shifts in due dates and adapting instructions for changes that occurred in the institution and clarity.

7. The Artefact

In this section more detail is provided on the design and logic of the artefact. Firstly, the context specifics will be highlighted, thereafter the scaffolded activities discussed followed by reflective insights gained from the study with a generic structure that could be adapted and applied to other contexts.

7.1 Context Specifics

The module for which the artefact was designed is a research module for post-graduate diploma students in computer science of which the group size is 20-30 students. They generally completed an undergraduate degree the previous year, most of them in computer science but there are usually some students with other undergraduate degrees. All students must have some programming background to study the post-graduate diploma. At the end of the semester students must receive ethical clearance from the institution for their study and submit a research proposal to continue with research and complete a research project in the following semester. These students are generally comfortable with technology, but their research experience is very limited. This means that the module is considered their first introduction to the academic research process. The researcher has taught the module for three years and has experienced a decline in student engagement, in some part due to in-depth feedback provided on submitted documents: the students do not see the value of coming to lectures if they get in-depth guidance on submitted text. The researcher is also comfortable with the institution's LMS which assisted in easy develop the artefact.

7.2 The Scaffolded Activities

In the artefact there are three types of assessments: token activities, formative assessments, and summative assessments. By completing and engaging with token activities students can earn 1 to 2 feedback tokens which can be exchanged for deeper levels of feedback in formative assessments. For 0 tokens a student would receive a basic level of feedback, this includes one-word verbs like "expand" or "clarify". 1 token would buy a student more detailed feedback like "expand on this specific concept, idea, or argument" or "clarify this specific word and what you mean here". Lastly, 2 tokens would buy a student the deepest level of feedback with more detail like "expand on this specific concept by referring to these ideas and arguments" or "clarify this word by explaining how it relates to your study". The token activities and formative assessments are scaffolded in such a way to ensure that a student is prepared for completing and submitting the summative assessment. In the summative assessment feedback tokens cannot be earned or exchanged. Figure 2 illustrates the structure and logic of the designed artefact.

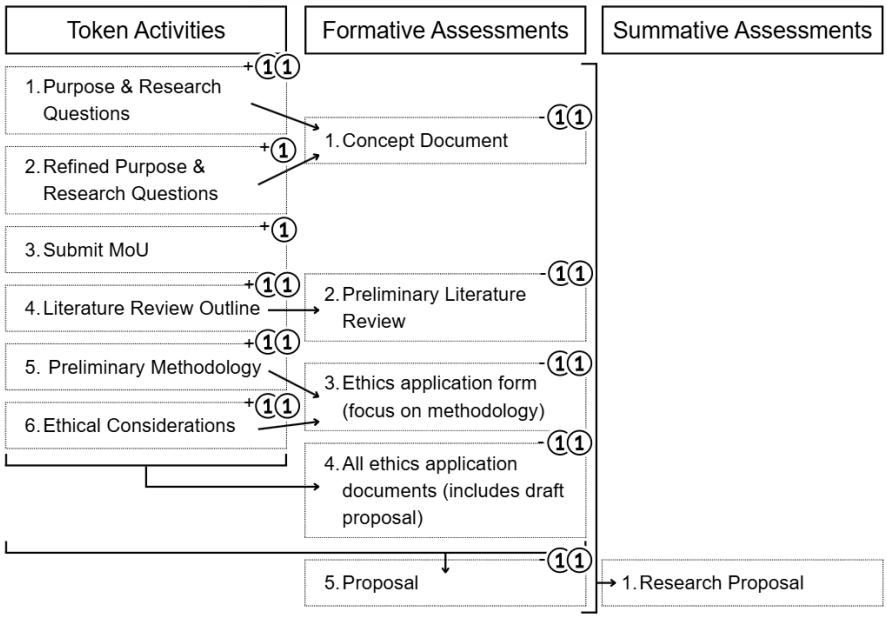


Fig. 2 The Designed Artefact

In Figure 2 the six token activities are listed first, each of these activities required the students to engage with a part of the research process. For activities 1, 4, 5, and 6 the students had to post their ideas on a discussion board and be ready to discuss and explain it in class. A post on the discussion board earned them 1 feedback token and if they also discussed it in class they received another token. Thus, for these activities there were 8 tokens available. It is necessary to note that a student needs to post on the discussion board first before they can view other's posts. For token activity 2 students had to refine their purpose and research questions in token activity 1 to receive 1 feedback token, this was specifically done to allocate supervisors. The first time a student develops a purpose and research questions it generally needs a lot of work, thus by having them post on a discussion board, discuss in class, receive verbal feedback and hear other student's ideas they would be able to better refine their ideas for token activity 2. Token activity 3 was the submission of the signed memorandum of understanding between the student and their supervisor for 1 feedback token. Token activities 1 and 2 were the prior experience to formative assessment 1, the concept document. A student would have been able to earn a total of 3 feedback tokens before submitting formative assessment 1 that would cost them 2 tokens for the deepest level of feedback. Token activity 4 directly related to formative assessment 2, the literature review. For the token activity students had to post their literature review outline on a discussion board for 1 token and then discuss it in class for informal verbal feedback and another token. If students earned and spent the most tokens possible, they would have 4 tokens of which they can exchange 2 for deeper feedback in the preliminary literature review. Token activities 5 and 6 could earn a student 2 tokens each and was the experience that built towards completing the ethical clearance application. For the token activities students had to refine their methodology and ethical considerations. At this point if students completed all activities and spent the most tokens possible, they should have 6 tokens which they can spend on formatives 3, 4, and 5, 2 tokens per assessment for the deepest level of feedback. For feedback assessment 4 students were required to submit all the documents required for ethical clearance which included a draft proposal meaning that all the token activities built towards them being able to complete the required documentation for ethical clearance. Lastly formative assessment 5 is an opportunity for students to buy deeper levels of feedback on their proposal before they submit it for the summative assessment, all the token activities and formative assessments were experiences geared to the students being able to successfully complete their proposal.

7.3 Reflective Insights from the Study

The reflective insights highlighted below can be divided into token management, lecturer perspective, the artefact design, expert insights, and further refinement.

Firstly, token management, initially this was a concern because one does not want to unnecessarily increase admin load. Initially while marking the formative assessments the lecturer had to figure out which tabs and windows were necessary, this was something that one needed to get use to but after a few repetitions she was more comfortable. Remembering to award the tokens was a challenge sometimes but this could easily be circumvented by marking while students discuss in class. Lastly awarding and exchanging tokens within the LMS was beneficial. External systems might add more features but having to work on two systems is not worth it.

Concerning the lecturer perspective there was an assumption that verbal feedback provided during the token activities would mean less feedback in formative assessments, this was not necessarily true. For the students that exchanged the maximum number of tokens providing timeously in-depth feedback was still required but the lecturer gave this gladly as the students were engaging in the classroom. On the other end time was saved during marking for the students who did not exchange tokens for deeper levels of feedback. Furthermore, some students were excited about earning and exchanging tokens which shifted the idea that feedback is something that one will simply receive if work is submitted to feedback requires engagement, is valuable and something one needs to work for.

Regarding general reflective insights of the artefact design, it worked well in the research module where there was one summative assessment at the end of the semester, and all other assessments build towards it. This could mean that it is easily transferable to modules where assessments work in a similar way. Figure 3 illustrates the structure designed and developed in this study.

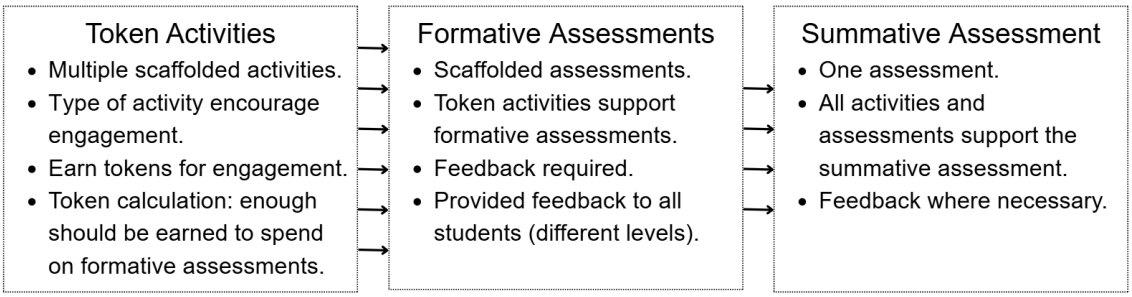


Fig. 3 Structure Gamifying Feedback in Research Modules

Figure 3 illustrates the elements to gamify feedback in research modules which could potentially be adapted to other modules where assessments require iteration and feedback that builds towards a final summative assessment. Important elements to note in Figure 3 is that token activities should be scaffolded, support and build towards the formative assessments, require some form of engagement from the student, and one should calculate the total tokens possible before formative assessments to ensure that students would have enough to exchange it for the deepest level of feedback. For formative assessments the important characteristic is that feedback is required. All students should receive feedback; the depth is dependent on the number of tokens they spend. These assessments should also be scaffolded and build towards the summative assessment. Through this structure a high value is assigned to the human element, lecturer feedback and peer interaction, in the research process. Upon reflection from the implementers perspective this is an interesting idea for further exploration in the age of AI. Many technologies could be used for students to earn tokens and gamify feedback but the idea that they must participate and engage in person to be able to exchange tokens for human, lecturer, time and attention shifts the focus to the importance of the human element. The student must engage to gain access to in-depth feedback from the lecturer.

Furthermore, the experts provided valuable insights of which some were included in the artefact design and others recommended for further development. Their discussions assisted in refining activity expectations and structure as well as motivating a more aesthetically pleasing artefact. Unfortunately, some discussions could only take place during the first implementation which meant that not all expert feedback was implemented as to not confuse students. Suggestions that are recommended for refinement include restructuring feedback types by adding more options and providing students the opportunity to select how they would want to receive the feedback.

Final thought post-implementation reflection to be considered for further refinement. Students started negotiating if they did not have enough tokens for in-depth feedback which leaves room for additional tasks to earn more tokens. Initial ideas regarding this include auto assessed quizzes, peer assessment, and presenting concepts in class. One could also consider the possibility of users gifting rewards to one another, but calculations to ensure viability would be vital before implementing. Students also asked about what happens if they have tokens left at the end of the semester whether they could exchange it for more feedback. This component needs further refinement and could possibly include one-on-one in-person consultation with the lecturer. Which would again assign more value to human interaction.

8. Conclusion

Through the process of DBR and using EL and Gamification principles an artefact to gamify feedback in research modules was developed. This paper described the research process followed and the structural design that was developed. From a practical perspective this study yielded an artefact that is stable and could be used for formal implementation, testing, and measurement. Further research recommendations include exploring lecturer and student perceptions and experiences, and measuring the impact on engagement and academic performance. From a more philosophical perspective this study brought about the idea to find ways to assign value to the human element in the learning process. In this specific study it was rewarding students with tokens for their engagement in a module and then exchanging this reward for access to the lecturer's time, knowledge and expertise. In our current day and age lecturers compete for students' attention and engagement against many forms of media and AI, and this artefact might be a step in the right direction by assigning tangible value to human interaction and engagement.

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Designing Project Courses with Purpose: How Benefiting Others Enhances Bachelor Student Motivation

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Abstract

Student motivation is a critical factor in computer science education, particularly in project-based courses where collaboration and sustained engagement are essential. Research in software engineering contexts shows that motivation strongly influences productivity and project outcomes, while low motivation is associated with project failure. In educational settings, this raises the question of how to foster not only external motivation, such as grades, but also intrinsic motivation, which is closely linked to deeper learning and long-term competence development.
This paper presents a case study from a Bachelor programme in Software Development, in which project courses across three years have been designed to include a purpose by engaging students in projects that benefit others, such as health-related applications and real-world collaborations. The study is grounded in Illeris' theory of learning, which conceptualizes learning as an interaction between cognitive, emotional, and social dimensions.
Data was collected through course evaluations, student reflections, surveys, and teacher observations. The results indicate that students' experience increased motivation, improved collaboration, and deeper engagement when working on meaningful projects. Furthermore, students demonstrate signs of developing professional identity and reflecting on their roles within teams.
The findings suggest that incorporating purpose-driven project design into computer science education can enhance both learning processes and student motivation, contributing to more effective and meaningful educational experiences.

Keywords: *Computer Science Education, Project-Based Learning, Intrinsic Motivation, Empathy, Service-Oriented Learning*

1. Introduction

Student motivation is a central factor in successful learning, particularly in computer science education, where project-based courses require sustained engagement and collaboration. In software engineering practice, motivation has been shown to significantly influence productivity, team performance, and project outcomes, while low motivation is associated with project failure [1][2].
In educational contexts, this highlights the importance of designing learning environments that support not only external motivation, such as grades and deadlines, but also intrinsic motivation. Intrinsic motivation is closely linked to engagement, persistence, and deeper learning processes, making it particularly relevant in complex and collaborative learning settings.
One approach to fostering intrinsic motivation is to introduce elements of purpose into learning activities. When students perceive their work as meaningful or beneficial to others, their engagement and commitment may increase. In computer science education, this can be achieved by designing project courses where students develop solutions for real-world problems, particularly in domains such as healthcare or social good.
This paper explores how purpose-driven project design, with a focus on benefiting others, influences student motivation and learning processes. The study is grounded in Illeris' theory of learning [3], which conceptualizes learning as an interaction between cognitive, emotional, and social dimensions.
The contribution of this paper is a case study from a bachelor's programme in Software Development, where project courses across three years have been designed to include elements of empathy and real-world impact. The study examines how this design choices affect students' motivation, collaboration, and learning.

2. Theoretical Background

2.1 Illeris' Three Dimensions of Learning

Illeris [3] describes learning as a process involving three interconnected dimensions, as outlined by Figure 1:

- Cognitive dimension, related to knowledge, understanding, and skills
- Emotional, or affective, dimension, including motivation, feelings, and volition
- Social dimension, involving interaction with others and the surrounding environment

Effective learning requires the integration of all three dimensions. The cognitive dimension alone is insufficient without emotional engagement and social interaction. Intrinsic motivation plays a key role in activating the emotional dimension, which in turn supports deeper cognitive processing.

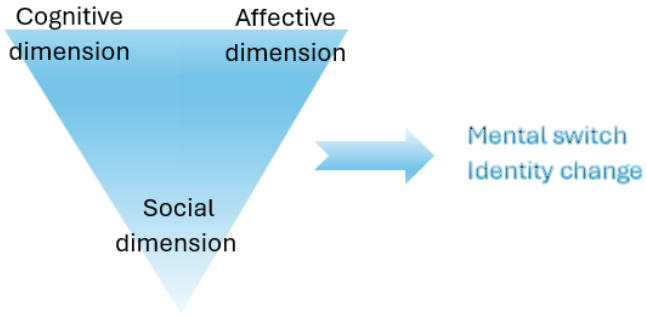


Fig. 2. the three dimensions that contribute to the outcomes that can be understood as a mental switch and identity change in software development students

The three dimensions jointly contribute to outcomes that can be understood as both a *mental switch* and an *identity change*. At the **cognitive dimension**, individuals revise their frames of reference, assumptions, and ways of interpreting situations, resulting in a mental switch toward new patterns of thinking. At the **affective dimension**, shifts in motivation, values, and emotional engagement support a deeper internalization of these new perspectives. Finally, at the **behavioral (or social) dimension**, sustained changes in actions, roles, and participation consolidate these transformations. Together, these dimensions interact to produce not only a temporary cognitive adjustment but a more enduring identity change, in which individuals come to see themselves differently in relation to their practices, roles, and communities.

2.2 Intrinsic Motivation and Empathy

Intrinsic motivation refers to engaging in an activity for its own sake, driven by interest, enjoyment, or perceived meaning. In contrast, extrinsic motivation is driven by external rewards such as grades or recognition.
Empathy and prosocial behavior have been shown to strengthen intrinsic motivation and support collaboration [4]. Activities that involve helping others can create a sense of purpose, which enhances engagement and persistence.
In educational contexts, this suggests that project design can play a crucial role in activating intrinsic motivation by connecting learning activities to meaningful real-world contexts.

2.3 Transformative Learning and Identity Development

Transformative learning involves changes in how individuals understand themselves and their roles, often described as shifts in perspective or identity [5]. Such changes are particularly relevant in professional education, where students gradually develop a sense of professional identity.
Project-based learning environments provide opportunities for such development, since students take on roles, collaborate in teams, and engage with realistic problems. These experiences can lead to increased self-awareness, confidence, and understanding of professional responsibilities.

3. Related Work

Student motivation and engagement have been widely studied in educational research. Fredricks, Blumenfeld, and Paris [6] conceptualize engagement as a multidimensional construct including behavioral, emotional, and cognitive components, highlighting the importance of addressing all three in effective learning environments.
Intrinsic motivation has been further developed within Self-Determination Theory (SDT) by Ryan and Deci [7], which emphasizes the role of autonomy, competence, and relatedness in supporting deep engagement and persistence in learning tasks.
Learning has also been described as a process involving identity transformation. Mezirow [8] argues that meaningful learning experiences can lead to changes in individuals' perspectives and self-understanding, particularly in contexts resembling real-world practice.
Additionally, research on achievement emotions underscores the role of emotions in the learning process. Pekrun [9] demonstrates how emotions, such as enjoyment and anxiety, influence motivation and performance, while Dahlqvist [10] shows how affective experiences shape students' learning in higher education.
Together, these perspectives suggest that learning environments should address not only cognitive aspects but also emotional engagement, intrinsic motivation, and identity development. This study builds on these insights by examining how purpose-driven project courses in computer science can support these dimensions through meaningful and socially relevant tasks.

4. Educational Context

The study is conducted within a three-year Bachelor programme in Software Development at Kristianstad University. The programme combines theoretical courses with project-based courses at the end of each academic year, where innovation is also used to promote engagement and motivation [11]. The project courses are designed to progressively develop students' technical skills, collaboration abilities, and professional identity. During the pandemic, the project courses continued to be delivered despite the challenges [*12*]. In addition, elements of purpose and empathy are introduced by framing projects around real-world problems, often related to healthcare or societal needs.

5. Method

This study employs a qualitative case study approach. Data were collected from:

- Course evaluations
- Student reflections
- Surveys
- Teacher observations

Participation in surveys and reflections was voluntary.
The analysis focuses on how students' experiences relate to the three dimensions of learning proposed by Illeris: cognitive, emotional, and social. Particular attention is given to indicators of motivation, engagement, collaboration, and identity development.

6. Study Cases

Three case studies are presented as outlined in Table 1. The study cases reflect on courses students take during their first, second, and third years, respectively. The programme syllabus is, furthermore, addressed in [13].

Table 1. Study cases

Study cases	Project description	Role-forming identity	Providing support to users
Agile methodology Year 1	4-5 students/group Students are free to decide on projects that focus on mental health	Scrum master Developer Tester Supporter	Supporting individuals with mental health challenges
Android development Year 2	4-5 students/group Students work with companies to develop a prototype	Consultant	Companies, University researchers, Institutions
Software engineering Year 3	13 students/group Designing and developing from scratch Smart home system	Project manager Requirements manager Subgroup-leader Developer Tester	Smart home users, including families as well as institutions such as hospitals

6.1 Agile Methodology (Year 1)

Students work in groups of 4–5 to develop applications related to mental health, more exactly SDG 3.4 Good Health and Well-being, is chosen by the teacher as a base for the project work, with the purpose of reaching the intrinsic motivation. They rotate between roles such as developer, tester, and scrum master.

The project emphasizes:

- Role exploration
- Reflection
- Empathy through application themes

6.2 Android Development (Year 2)

Students collaborate with external partners, such as companies or researchers, to develop mobile applications. They work in a consultant-like role, interacting with stakeholders and managing real-world requirements.

6.3 Software Engineering (Year 3)

Students work in larger teams (approximately 13 students) to design and develop complete systems, such as smart home solutions. The project simulates professional environments with multiple roles and sub-teams.

7. Results and Analysis

Transformative learning (TL) can be understood as a form of confirmation for us as educators that students' learning has taken place. This confirmation is reflected in multiple sources, including students' responses in course evaluations and questionnaires, their project presentations, and the ongoing dialogue between teachers and students throughout the course of the project. Through these interactions, it becomes evident that students develop in terms of their identity. For example, one student may come to realize that they do not enjoy working in a leadership role, while another discovers a strong affinity for leadership and subsequently expresses an interest in further education or courses related to leadership.

The results are first presented in Table 2 and briefly reflected from the perspective of Illeris' dimensions of learning, and followed by a discussion grounded and motivated across levels of course evaluations and observations of students' attitudes.

Table 2. Students' reflections on project work

	Students' reflections	Empathy	Cognitive	Emotional	Social	Identity
Benefits of using a real-case approach in project work	*"Is really great to have group mates working alongside, where we can help each other and ask questions when stuck."*	✓		✓	✓	
	"Everyone works together and must be involved since companies are dependent on us- pressure to do well"	✓	✓	✓	✓	
	"Having to work on a real application that someone would use in future made it even more motivating. Meeting with teacher and company were also an asset to making sure we are on the right track."	✓		✓	✓	
Challenges of working on a real-case project	*"Since it's a limited time it is important that the companies understand it as well."*		✓	✓		
	"Time limitation, due to unknown fields (what companies want) and limited time for improving own abilities."		✓	✓		✓
	"It could be hard for someone who didn't work with clients earlier. As dealing with clients can require certain skills to drive the project further."	✓	✓			
Impact on knowledge, skills, and professional identity	*"This project has affected my skills and knowledge as I was able to work with new tools including real time database e.t.c. it also boosted my confidence as I was able to contribute to an actual company and assist them in solving a need."*	✓	✓	✓		✓
	"I feel more confident in my abilities to solve a lot of tasks and my ability to work with companies and in groups in a good way. So I have a greatly improved image of myself as a future professional."		✓	✓	✓	✓
	"The project has enabled me to understand how it is working for a company and understanding how to operate with deadlines. Regarding future professional I feel that I am more prepared and also that as mentioned before I feel like I got a better understanding of how real work is."		✓	✓		✓

Cognitive Dimension - Students demonstrated increased ability to apply knowledge in complex and realistic contexts. Projects required integration of skills across programming, system design, and collaboration.

Emotional Dimension - Students reported increased motivation, particularly when projects were perceived as meaningful. Students also appreciated having autonomy in project design, which contributed to engagement and ownership.

Social Dimension - Collaboration improved across all project courses. Students developed communication skills and a better understanding of team roles.

Working with external stakeholders further strengthened their ability to interact in professional contexts.

Identity Development - Students showed signs of developing professional identity. Some discovered preferences for specific roles, while others gained confidence in their abilities. These changes indicate elements of transformative learning, where students not only acquire knowledge but also reshape their understanding of themselves.

7.1 Agile Methodology Course

The survey results show that the students felt more motivated to learn when they were given the freedom to decide what kind of app to develop, even though teachers set the theme as mental health. Students felt that changing roles engaged them to seek out more knowledge before they turn over their role work to the next student. Walking in others' shoes gives students insight into their own knowledge and identifies areas where they can improve.
The weekly reflections indicate a progressive development consistent with transformative learning theory. Early reflections show students critically engaging with initial assumptions regarding teamwork, roles, and project planning. As the project advanced, students described changes in perspectives related to collaboration, tool usage, and problem-solving, supported by increased reflection, dialogue, and adaptive action. By the final phase, students demonstrated not only improved technical competence and stable teamwork but also evidence of perspective transformation, expressed through enhanced professional confidence, clearer role awareness, and emerging insights into personal preferences for responsibility and leadership. These findings suggest that learning extended beyond skill acquisition to include shifts in students' frames of reference and professional identity.

> *It was as really beneficial to work in a "work like" environment prior to working in the industry and building up team related skills and trying out different roles. This is especially beneficial as it gave creative freedom to a degree to do what we want to and expand our own skill set based off of that which was a lovely experience.*

Fig. 3. The citation was taken from the course evaluation

Myrmydon [14] is one of the many examples, including applications developed by students with a focus on mental health, striving to help another human.

7.2 Android Development Course

The results from Android development projects on motivation and on working with customers as consultants point out that many students felt it was challenging to work with companies, but they did develop a successful application in the end. Students felt that it was much time-consuming and wished for longer time to develop. Students also reported that they got proper experience and company connections. Students had varying perspectives on their skills and future professional development, with some being less focused on it and others expressing interest in working as consultants in the mobile industry. This way of working was positively received and recommended by students for continued implementation in the programme.

> - *Both hurt my confidence and patched it up and rebuilt it.*
> - *This course has helped me develop my skills a lot and even realise a lot of my strenghts and weaknesses.*

Fig. 4. Reflections about motivation and working with customers shared by two students

One example of an Android app developed in cooperation with a company is an app that prevents littering [15].

7.3 Software Engineering Course

Teachers observed that students felt frustrated at the beginning of the project, when they needed to find their own place in the group. Many students struggled to see how the project would progress, how collaboration would function, and what the completed project would ultimately look like. To address this challenge, teachers recommend the group leaders based on students' grades and communication abilities demonstrated in previous courses. It was beneficial that the projects were designed with the purpose of benefiting their target users. The leaders used the knowledge about the target users to gather the group and provide them with a clear goal, both in the technical area, and to develop a product that

focuses on the needs of product users, families, disabled people, or hospitals. Reaching the end of the project, students realized and felt safe in what their role is and what they shall deliver, how communication flows, and what tools are used. Students felt very proud of their own achievement at the end of the project.

> *It succeeds in forcing students into a real life scenario of being a part of a company. The instructors gave us freedom of choice to some extent to direct the project on own, which leaves room for creativity.*

Fig. 5. Student's reflection on motivation and on the project role

An example of a smart home system involves the use of Brain Computer Interface (BCI) to assist in interacting with the house [16].

8. Discussion

The findings suggest that purpose-driven project design can positively influence all three dimensions of learning.

- The cognitive dimension is strengthened through complex, real-world problem solving
- The emotional dimension is activated through meaningful and empathetic contexts
- The social dimension is enhanced through collaboration and interaction

The use of empathy as a design principle appears to be particularly effective in fostering intrinsic motivation. When students perceive their work as meaningful, they become more engaged and invested in the learning process.
The findings align with prior research on engagement and motivation. In line with Fredricks et al. [6], students show not only behavioral participation but also emotional and cognitive engagement in meaningful project contexts. The course design supports intrinsic motivation as described by Ryan and Deci [7], through autonomy, competence development, and collaboration.
Students' reflections further suggest elements of identity development, consistent with Mezirow [8], while the observed role of emotional involvement aligns with research on achievement emotions by Pekrun [9] and Dahlqvist [10].
However, not all students are equally motivated by empathy-based approaches. Future work should explore how different motivational strategies can be combined to support a broader range of students.

9. Conclusion

This paper demonstrates that integrating purpose and empathy into project-based courses can enhance student motivation, engagement, and learning. By aligning project work with real-world needs, students not only develop technical skills but also gain a deeper understanding of their roles as future professionals. The results suggest that purpose-driven design should be considered an important component in the development of computer science education.

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Recalibrating Confidence through Participation: A Design-Based Study of Virtual Student Mobility in a Generative AI–Supported Learning Environment

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Abstract

Many educators intuitively recognise that meaningful international learning does not simply increase students' confidence; rather, it often leads learners to become more aware of the limits of their own abilities and understanding. Despite this shared intuition, how such moments of awareness emerge, and how they appear in empirical data, has remained largely a black box in international and digital learning research. As technology-mediated global learning environments become more prevalent, learning outcomes are often measured by gains in confidence or self-assessed competence. In contexts characterised by complexity, uncertainty, and authentic participation, however, such interpretations may overlook important dimensions of learning. This study adopts a design-based research (DBR) perspective to examine how participation in a semester-long, synchronous Virtual Student Mobility (VSM) course reshaped Japanese university students' self-perceptions of intercultural competence (McKenney & Reeves, 2018). In this course, Japanese students participated remotely and in real time in an undergraduate course offered at a U.S. university, engaging alongside local students in lectures, discussions, and collaborative activities within a technology- and generative AI–supported learning environment designed to scaffold participation and comprehension. A pre-post survey informed by the OECD PISA Global Competence Framework (2018) and an integrated intercultural competence scale developed by Fantini were administered, with 41 students enrolled in the 2025 courses voluntarily completing both surveys. Contrary to expectations, post-course self-assessment scores declined across most survey items. Rather than interpreting this decline as a negative outcome, the study situates the findings within the design of the learning environment itself. Quantitative results are examined alongside qualitative end-of-course reflections, which consistently indicated deeper awareness, heightened recognition of communicative complexity, and increased reflective engagement. This apparent tension highlights a critical but often underexplored phase of learning: the recalibration of learners' self-perceptions following authentic participation in complex learning settings. By foregrounding learning design as the unit of analysis, this study reframes decreased confidence not as failure, but as a meaningful indicator of learning in future-oriented, technology-enhanced environments. The findings suggest a need to rethink assessment practices in global digital learning and offer design implications for supporting learners as they navigate uncertainty and emerging awareness.

Keywords: *Virtual Student Mobility (VSM), Learning Design, Future-Oriented Learning Environments, Student Engagement, Self-Assessment and Recalibration, Design-Based Research (DBR)*

1. Introduction

As technology-mediated international learning environments continue to expand in higher education, Virtual Student Mobility (VSM) has emerged as an increasingly accessible way for students to participate in global learning experiences without physical travel [1]. Alongside this development, generative AI-supported tools such as automatic subtitles, translation systems, and AI-generated summaries are rapidly being integrated into online learning environments to support comprehension and communication across linguistic and cultural differences. Within this context, successful learning outcomes in virtual exchange and COIL environments are often discussed in terms of increased intercultural competence, greater confidence, or improved self-perceived communicative ability [2], [3], [4], [5]. However, authentic participation in complex international learning environments may not always increase learners' confidence. In some cases, direct engagement with unfamiliar academic and intercultural contexts may instead increase awareness of the limits of one's own communicative ability. Although educators often recognise this phenomenon intuitively, it remains underexplored in research relying heavily on self-report measures of confidence and competence. As a result, decreases in self-assessment scores are frequently interpreted negatively. This study argues that such interpretations

may overlook an important dimension of learning in complex, participation-oriented environments. Rather than viewing reduced confidence as a failure, this paper examines the possibility that changing self-perceptions may reflect a meaningful recalibration process emerging through authentic participation. From this perspective, learning involves not only acquiring skills or confidence, but also developing a more realistic and reflective understanding of one's own abilities within socially and culturally situated contexts.

To explore this issue, the present study adopts a DBR perspective [6] to examine a semester-long synchronous VSM programme connecting a Japanese university and a U.S. university. In this learning environment, Japanese students participated remotely and in real time in undergraduate courses alongside local U.S. students. The environment incorporated multiple forms of technological and generative AI support, including live captions, translation support, recorded sessions, and AI-assisted summaries, with the aim of lowering barriers to participation while maintaining authentic interaction and academic complexity. Using pre-post survey data informed by the OECD PISA Global Competence Framework [7] and intercultural competence measures developed by Fantini [8], together with qualitative end-of-course reflections, this study investigates how students' self-perceptions changed through participation in this AI-supported VSM environment. Particular attention is given to the apparent contradiction between declining self-assessment scores and students' qualitative reports of deeper awareness, increased reflection, and heightened recognition of communicative complexity. By foregrounding learning design and participation as the central analytical lens, this paper proposes that decreased confidence may, in some contexts, function as a meaningful indicator of learning rather than its absence.

2. Literature Review

2.1 Virtual Student Mobility and International Online Learning

Virtual Student Mobility (VSM) has emerged as an important approach to expanding access to international learning opportunities in higher education, particularly in contexts where physical mobility is limited by financial, geographical, or institutional constraints. The OECD [1] describes virtual mobility as a form of technology-mediated international learning that enables students to participate in educational experiences across borders without travelling physically. Unlike asynchronous online exchange projects, synchronous VSM environments often require students to participate directly in live classes, discussions, and collaborative activities alongside students from partner institutions, creating opportunities for authentic intercultural interaction in real time.

At the same time, participation in such environments can involve considerable linguistic, cultural, and communicative complexity. Previous research on virtual exchange and online international learning has reported benefits including increased intercultural awareness, communication skills, confidence, and global engagement [3], [9]. However, successful participation in these environments requires more than technological access alone. Learners must also navigate unfamiliar interactional norms, disciplinary expectations, and real-time communication demands within multilingual settings. Recent developments in generative AI and learning technologies have further transformed the conditions of participation in online international learning. Tools such as automatic subtitles, machine translation, and AI-generated summaries may help reduce comprehension barriers and support learners' access to classroom interaction. Nevertheless, technological support does not automatically guarantee meaningful participation. Instead, how such tools are integrated into the learning environment through intentional learning design may play a critical role in shaping students' experiences of participation and engagement.

2.2 Confidence, Self-Assessment, and Intercultural Competence

Intercultural competence has frequently been evaluated through self-report measures examining learners' confidence, attitudes, and perceived communicative ability. Frameworks such as the OECD PISA Global Competence Framework [7] and Fantini's intercultural competence model [8] have contributed significantly to understanding how learners perceive their intercultural development in global learning contexts. In many studies, increases in self-assessed competence are often interpreted as evidence of successful learning outcomes. Recent COIL and virtual exchange studies have similarly reported positive changes in learners' intercultural confidence, effectiveness, and perceived communicative ability following participation in international online learning environments [4]. However, self-assessment in intercultural and multilingual contexts may involve important limitations. Learners entering unfamiliar communicative environments may initially overestimate their abilities due to limited

exposure to authentic intercultural interaction. Through sustained participation, they may become increasingly aware of communicative nuance, cultural complexity, and gaps in their own understanding. As a result, declining self-assessment scores do not necessarily indicate reduced competence, but may instead reflect deeper awareness and more critical self-reflection.
This interpretation aligns with perspectives in educational research that view learning as a process involving uncertainty, reflection, and the restructuring of prior assumptions. In complex learning environments, increased awareness of difficulty may represent an important stage of learner development rather than evidence of failure. Nevertheless, this possibility remains underexplored in research on technology-enhanced international learning environments, particularly in studies relying primarily on quantitative self-report measures.

2.3 Learning Design and Design-Based Research

This study adopts a DBR perspective, which views educational interventions as iterative learning designs situated within authentic learning contexts [6]. Rather than focusing solely on technological tools or learner outcomes in isolation, DBR emphasises the relationship between learning environment design, participation processes, and emerging forms of learning. From this perspective, generative AI tools are understood not as solutions that automatically improve learning, but as mediating resources within broader participation-oriented learning environments. In the present study, the learning environment was intentionally designed to support access to authentic participation while preserving the complexity of real-time intercultural interaction. AI-supported tools functioned as scaffolds to assist comprehension and continuity of participation, rather than as mechanisms for simplifying or replacing interaction itself. Accordingly, this study foregrounds learning design as the primary unit of analysis in examining how students' self-perceptions changed through participation in an AI-supported VSM environment.

3. Context and Learning Environment

The present study was conducted within a semester-long synchronous VSM programme collaboratively implemented between a Japanese university and a U.S. university. In this programme, Japanese undergraduate students participated remotely and in real time in regular undergraduate courses offered at the U.S. institution. Rather than participating in a separate exchange programme designed exclusively for international students, participants joined mainstream classes alongside local U.S. students and engaged in lectures, classroom discussions, and collaborative learning activities conducted fully in English.
The VSM courses were designed to provide students with opportunities for authentic participation in an international academic environment while remaining physically located in Japan. Throughout the semester, students attended weekly live classes via Zoom and interacted with instructors and peers in real time. The courses addressed socially and culturally complex topics related to areas such as ethnicity, society, and culture, requiring students to engage not only linguistically but also intellectually and interculturally within unfamiliar academic contexts. To support participation in this environment, multiple forms of technological and generative AI support were integrated into the learning design. These included live automatic captions, AI-assisted translation support, recorded sessions, and AI-generated summaries that allowed students to revisit classroom interaction after class. In addition, the learning management system (LMS) was used to provide supplementary materials, instructions, and opportunities for reflection throughout the semester.
Importantly, these technological supports were not intended to simplify the learning experience or remove communicative difficulty entirely. Instead, the learning environment was intentionally designed to lower barriers to participation while maintaining the complexity and unpredictability of authentic interaction. Students were still required to interpret meaning in real time, negotiate unfamiliar perspectives, and manage the challenges of participating in a multilingual and intercultural classroom environment. From this perspective, generative AI functioned primarily as a scaffold supporting access to participation rather than as a replacement for communicative effort or intercultural engagement. The design of the VSM environment reflected the assumption that participation itself constitutes an important site of learning. Rather than positioning students as passive recipients of international content, the programme aimed to situate learners within authentic social and academic interaction where awareness, uncertainty, and self-reflection could emerge through direct engagement. This design orientation became particularly important in interpreting changes observed in students' self-assessments over the duration of the course.

4. Methodology

This study employed a pre-post survey design within a DBR framework to examine changes in Japanese university students' self-perceptions following participation in a synchronous VSM course. The study focused not only on learning outcomes, but also on how participation in an AI-supported international learning environment reshaped students' perceptions of intercultural communication and participation. The study was conducted during the Fall 2025 semester in a U.S.-linked undergraduate course involving Japanese students participating remotely and synchronously in regular U.S. university classes. A total of 60 students were enrolled in the programme, and 41 students voluntarily completed both the pre-course and post-course surveys. Only matched responses from these participants were included in the analysis.

The surveys were administered at two time points: at the beginning of the semester and after completion of the course. The questionnaire consisted of self-report items related to intercultural understanding, communication, and participation in international online learning contexts. Drawing on the OECD PISA Global Competence Framework [7] and Fantini's intercultural competence framework [8], survey items were organised into six conceptual categories: (A) attitudes and values, (B) cultural self-awareness, (C) practical communication skills, (D) collaboration and interaction, (E) learner agency, and (F) inclusivity and responsibility. All items were rated using a five-point Likert scale. Mean and median values were calculated for each category, and pre-post differences were examined descriptively. In addition to the quantitative survey, an end-of-course feedback survey was conducted to gather qualitative reflections regarding students' learning experiences. These open-ended responses were used to contextualise and interpret the quantitative findings, particularly regarding students' perceptions of communicative difficulty, participation, and intercultural awareness.

5. Findings

5.1 Quantitative Findings

Analysis of the pre-post survey results revealed that post-course self-assessment scores decreased across nearly all survey categories. While students generally reported high levels of confidence and positive attitudes at the beginning of the semester, their evaluations became lower following participation in the U.S.-linked VSM course. Table 1 presents the mean and median scores for each survey category before and after the course.

Table 1. Pre–Post Survey Comparison of Japanese Students' Self-Assessment Scores (Fall 2025)

Group	Category	Pre Avg.	Post Avg.	Pre Median	Post Median
A	Attitudes & Values	4.87	4.70	5.0	5.0
B	Cultural Self-Awareness	4.70	4.45	5.0	5.0
C	Practical Communication Skills	3.98	3.54	4.0	4.0
D	Collaboration & Interaction	4.40	4.34	5.0	4.0
E	Learner Agency	4.62	4.67	5.0	5.0
F	Inclusivity & Responsibility	4.52	4.41	5.0	4.5

The largest decreases were observed in Group C (Practical Communication Skills) and Group B (Cultural Self-Awareness). In particular, items related to confidence in communicating with speakers from different linguistic backgrounds, explaining ideas clearly in intercultural settings, and managing communication difficulties showed noticeable declines. In contrast, Groups A (Attitudes & Values) and F (Inclusivity & Responsibility) demonstrated relatively smaller changes. Examination of the median values suggests that many attitudinal items had already been rated very highly at the beginning of the semester, indicating a possible ceiling effect in the pre-survey. Overall, the findings indicate a pattern in which students entered the course with highly positive self-perceptions, but evaluated their intercultural communication abilities more cautiously after completing the semester-long VSM experience.

5.2 Qualitative Findings

Qualitative responses collected through the end-of-course feedback survey provided important contextual support for the quantitative findings. Overall, students evaluated the course positively in terms of learning value, instructional quality, and the opportunity to participate in a U.S. university course. Many described the experience as meaningful, stimulating, and valuable for their personal and academic development. At the same time, students frequently referred to the challenges associated with participating in real-time English-medium classes. Common themes included the speed and spontaneity of discussion, difficulty initiating contributions, and uncertainty during intercultural interaction. Several students explicitly reflected on becoming more aware of their own limitations in intercultural communication despite initially believing they could manage such interaction successfully.

These qualitative reflections suggest that the decline observed in post-course self-assessment scores was not associated with dissatisfaction or disengagement. Rather, students' responses indicate that direct participation in authentic intercultural interaction prompted deeper reflection on the complexity of communication in multilingual academic settings. This tendency was particularly visible in areas related to practical communication skills, where students appeared to reassess their abilities based on lived communicative experience rather than abstract assumptions.

6. Discussion

The decline observed in students' post-course self-assessment scores should not be interpreted as evidence of negative learning outcomes or reduced intercultural competence. Instead, the combined quantitative and qualitative findings suggest a process of recalibration in students' self-perceptions following sustained participation in an authentic intercultural learning environment. Prior to the course, many students reported very high levels of confidence and positive attitudes toward intercultural interaction. However, participation in the U.S.-linked course exposed students to the realities of spontaneous English discussion, diverse interactional norms, and the cognitive demands of real-time participation in a multilingual academic environment. Through these experiences, students appeared to develop a more cautious and realistic understanding of their own communicative abilities.

The particularly large decrease observed in Group C (Practical Communication Skills) is significant in this regard. The findings suggest that confidence in intercultural communication may initially reflect idealised or assumed self-perceptions rather than experience-based understanding. Through authentic participation, students moved from a general belief that they "could probably communicate" toward a more situated awareness of the complexity of actual intercultural interaction. As summarised in the course analysis, students appeared to shift from "I think I can do this" to "I realise how complex this actually is." Importantly, the qualitative feedback demonstrates that lower self-assessment did not coexist with negative attitudes toward the course. On the contrary, students simultaneously reported high levels of satisfaction, meaningful learning, and increased awareness of intercultural communication challenges. This tension suggests that productive difficulty and increased reflective awareness may represent important dimensions of learning in international online education. From a learning design perspective, the findings also highlight the role of generative AI-supported learning environments in shaping conditions for participation. Tools such as live captions, translation support, and AI-generated summaries may have lowered barriers to comprehension and enabled sustained participation in the course. However, these tools did not eliminate communicative complexity itself. Rather, they supported students' access to authentic interaction while preserving the uncertainty and challenge inherent in intercultural communication.

7. Conclusion

This study examined how participation in an AI-supported VSM environment influenced Japanese university students' self-perceptions of intercultural communication and participation. While pre–post survey results showed decreases across many self-assessment categories, qualitative reflections suggested that students experienced the course as meaningful, challenging, and intellectually valuable. The findings indicate that authentic participation in complex intercultural learning environments may prompt learners to reassess their communicative abilities more realistically. From this perspective, reduced confidence may reflect an important stage of learning rather than evidence of failure.

The study also highlights the importance of learning design in AI-supported international education. Although generative AI tools may support access to participation, they do not eliminate the complexity

of intercultural communication itself. The findings suggest the importance of more nuanced interpretations of self-report measures and learner development in authentic participation contexts.
For policy-makers and institutional leaders, the findings suggest the importance of supporting learning designs that combine technological scaffolding with authentic interaction and guided reflection, rather than assuming that the introduction of AI tools alone will lead to meaningful participation. Such support is particularly important in virtual international learning environments, where students may need structured opportunities to engage with uncertainty, interactional complexity, and emerging awareness of their own abilities and limitations.

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Dancing with DNA: A Gamified Learning Approach for Enhanced Educational Experience

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Abstract

Among all the sciences, biology holds a unique place: it is the science of life itself, the key to understanding who we are and the ecosystems we depend on. Yet despite its relevance, biology is often perceived as difficult and abstract, confined to laboratories or textbooks. Making it accessible, engaging, and compelling is therefore one of the most pressing challenges of modern science communication. The ability to communicate science effectively while balancing accuracy and creativity has become increasingly essential. Several educational approaches can be used to spark students' interest in STEM disciplines. In particular, gamification can be a valuable learning tool to support pupils in studying biological sciences while having fun. In this work, we present the educational activity "Dancing with DNA" (original title "La Danza del DNA"), designed for primary and middle school pupils (8-12 years old), to introduce fundamental biological topics such as the cell cycle and DNA replication. The activity was tested in both formal educational settings (primary and middle schools) and informal educational environments (open-access events). This paper reports on the experience conducted during the Genoa Science Festival 2025, Italy's largest science communication event. The workshop consisted of an initial training phase including images, videos, and 2D and 3D models. Pupils were then engaged in a practical and playful activity aimed at illustrating the mechanisms of DNA duplication and cell division. Each participant acted as a nucleotide of the DNA molecule (adenine, thymine, cytosine, or guanine, A-T-G-C) or as one of the proteins involved in the biological process; working together, they simulated DNA replication by applying the rules of complementary base pairing (A::T, C::G). The feedback collected to evaluate scientific engagement, self-perceived learning, and enjoyment suggests that the activity supported perceived learning and was well appreciated by students, regardless of their initial familiarity with DNA. Teachers' evaluations were also highly positive, with the practical component emerging as the main driver of satisfaction. This case study strengthens the potential of a gamification-based approach and supports the integration of gamified learning into science education and communication strategies.

Keywords: *gamification; science communication; biology; DNA*

1. Introduction

Gamification, defined as the integration of game-design elements in non-game contexts [1], is an emerging paradigm attracting significant attention for its innovative potential. In teaching and educational contexts, gamification leverages "game-based mechanisms, aesthetics, and game thinking to engage people, motivate action, promote learning, and solve problems" [2]. At its heart, gamification operates on the principle that the motivational strength of game elements can be effectively transposed into educational settings. This method does more than make learning fun: it creates a safe environment for trial and error, encouraging students to experiment without fear of failure while transforming the learning process into an engaging and rewarding experience [3]. Indeed, gamification aims to boost intrinsic motivators, such as enjoyment and enthusiasm, to promote learning [4]. Therefore, gamification's role is to "affect psychological factors that mediate the learning outcomes" [5]. STEM education is a pivotal component of modern education, as it fosters active and responsible citizenship while highlighting the importance of science for young women and helping to bridge the gender gap. In this context, a primary objective of modern science communication is to ensure that biological knowledge remains accessible, intelligible, and engaging, a goal that increasingly requires balancing scientific accuracy with creative efficacy. The integration of gamification as a learning tool offers a valuable way to support young pupils in studying biological sciences through an enjoyable and interactive approach. By integrating game mechanics into science lessons, gamification can help

overcome traditional educational barriers, boost students' motivation and enjoyment, and enhance cognitive and metacognitive performance [6]. Although biology is the fundamental science of life, it is frequently perceived as complex and challenging; many students find it difficult to visualise and conceptualise core biological mechanisms, such as cell division and DNA replication. To address this challenge and facilitate a deeper understanding of their three-dimensional nature, we developed a kinaesthetic educational activity entitled "Dancing with DNA". The workshop was tested in both formal educational settings (primary and lower secondary schools) and informal educational environments (open-access events). This paper reports on the experience conducted during the Genoa Science Festival 2025, Italy's largest science communication event, which attracted more than 200,000 visitors from October 23rd to November 2nd, 2025. Inspired by "Weaves" (original title in Italian: "Intrecci"), the theme of this Festival edition, we presented our workshop "Dancing with DNA" [7]. Assessments of scientific engagement, self-perceived learning, and overall enjoyment suggest that the activity fostered perceived learning. Furthermore, the experience was met with great enthusiasm by students across both primary and lower secondary school levels. Teachers' evaluations were also highly positive, with the practical component emerging as the main driver of satisfaction. This case study underscores the potential of gamified approaches and contributes to the growing body of evidence supporting active and engaging learning strategies, thereby advocating for the integration of gamified learning into science education and communication strategies.

2. Dancing with DNA: Inside the Mechanics of the Gamified Learning Format

The DNA molecule - the foundation of life as we know it and the blueprint of every living being - engages in a true dance every time it replicates, as two strands intertwine in space to weave a new double helix [8]. "Dancing with DNA" is an active learning exercise that focuses on DNA replication and cell division and is designed especially for primary and middle school pupils (8-12 years old). Our aim was to allow participants themselves to become the DNA molecule, physically moving their bodies through the core stages of cellular life. This kinaesthetic role-playing format can be used to visualise how nucleotides link up, how base pairs form, and how the replication process gives rise to two new DNA molecules belonging to the two daughter cells. The workshop lasts about 45 minutes and can involve up to 60 participants. It was held in a large hall within the School of Robotics building in Genoa, which provided an appropriate setting for the game dynamics. During the Science Festival, two facilitators with university-level training in biology managed all activities for each scheduled session. Before the Festival began, we met with the facilitators to share the key workshop information and suggestions for adapting the playful component to different classroom contexts. The workshop starts with a training session designed to capture the audience's attention and make the scientific content accessible to everyone. Using visual storytelling - including drawings, videos, and real-world examples - participants journey inside the cell to explore how cells divide, why duplication is necessary, and how DNA duplicates itself to produce two identical molecules ready for the newly formed cells. Once the training session is completed, each participant receives a colour-coded tile representing one of the four nucleotides, transforming complex molecules into tangible building blocks and the four chemical bases into a physical game of DNA assembly. Half of the participants are asked to align themselves as a small region of a DNA molecule, simulating its ladder-like shape. They are told to form two parallel lines, using one hand to simulate the bond between the nitrogenous bases (base pairing) and the other to simulate the 3' hydroxyl bond. In this way, each participant places one hand on the shoulder of the child in front of them and joins the other hand to the child next to them in the parallel line (Fig. 1 upper panel). In addition to nucleotides, some volunteers play special roles as part of the molecular machinery (the enzymes) that coordinates the process: helicase ("the unzipper"), which separates the parental double-stranded molecule by breaking the hydrogen bonds between nucleotides; polymerase ("the builder"), which brings free nucleotides to their correct partners to form the complementary DNA strands; and ligase ("the gluer"), which forms the new bonds between nucleotides. The experience then evolves into a living DNA model, with each participant playing the role of a specific nucleotide or protein (Fig. 1 lower panel). By stepping into the role of the molecule itself, pupils can visualise how nucleotides link up and how base pairs form. The crucial task is to keep the base-pairing rules in mind: A always pairs with T, and C always pairs with G. To keep the simulation realistic, participants also have to respect a vital balance between speed and accuracy. Just like the enzymes in our cells, they have to work quickly while maintaining focus, because a single pairing error can lead to a DNA mutation. To set the beat for this hands-on phase, we chose Queen's "We Will Rock You", using its iconic rhythm to turn the simulation of DNA replication into an engaging, choreographed dance. Once the mission is accomplished, participants are

invited to look around: the original DNA molecule has successfully replicated, resulting in two identical DNA helices ready for the next generation of cells.

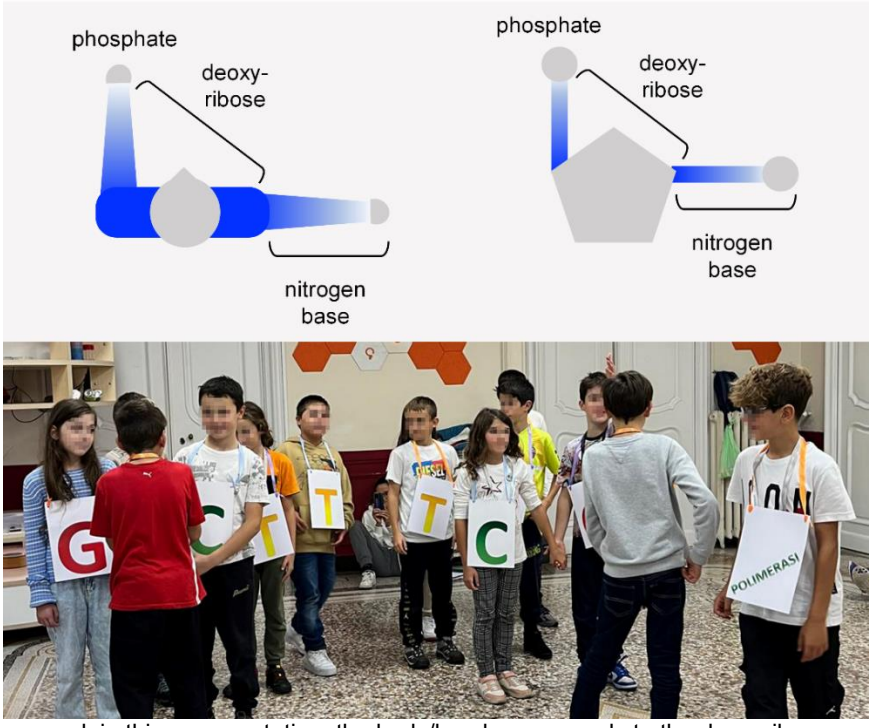


Fig. 1. Upper panel: in this representation, the body/head corresponds to the deoxyribose sugar; the arm extended horizontally to the right (in this case) is the nitrogenous base, which pairs with that of a complementary "nucleotide student" within the complete double helix; the arm extended forwards corresponds to the phosphate backbone. Lower panel: representative image of students participating in the workshop.

3. Assessment of the Impact of the Workshop

Approximately 1,000 individuals attended the workshop during the festival. Due to the large number of participants and the rapid succession of sessions, conducting a robust assessment of impact, objective learning outcomes, and long-term follow-up proved challenging. After each session, both students and teachers were invited to provide feedback on their overall experience with the educational activity through anonymous questionnaires. Students' learning outcomes should be interpreted as indicative and self-reported, due to self-selection bias and the inability to establish participants' baseline knowledge before the workshop. To ensure accessibility and ease of understanding for young primary and middle school pupils, a five-point Likert scale (1 to 5) accompanied by facial-expression icons was used to represent varying degrees of understanding and satisfaction (Fig. 2 left panel). This visual support facilitated engagement and interpretation, ensuring that the questionnaire was age-appropriate and effective for data collection. The questionnaire included three items: Q1, "Before this workshop, how much did you know about DNA?" (prior DNA knowledge); Q2, "How much do you think you learned from this workshop?" (perceived learning from the workshop); and Q3, "How much did you enjoy the workshop?" (workshop enjoyment). These items helped differentiate baseline familiarity from perceived learning gain and emotional involvement. Students were invited to tick the column featuring the emoji that best represented their level of knowledge, learning, and enjoyment; these responses were collected cumulatively across three large-format sheets, each dedicated to one of the three categories. As an interactive and engaging way to gather feedback on the hands-on activity, young participants were also invited to leave a comment or drawing using post-its and coloured pencils, sticking them onto a designated panel (Fig. 2 right panel). In addition, facilitators conducted a qualitative assessment by observing participants' behaviour and noting high levels of engagement throughout the workshops.

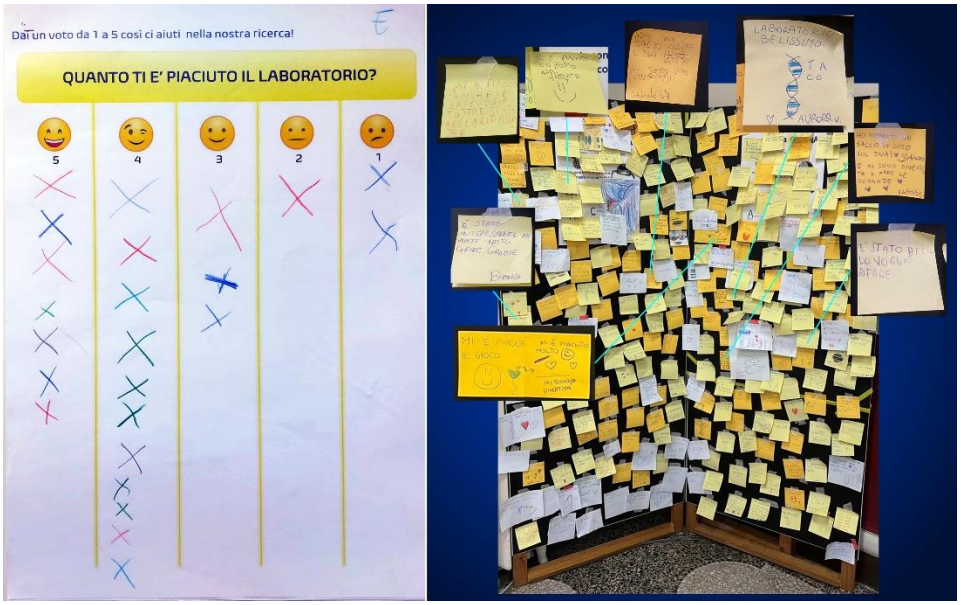


Fig. 2. On the left: example of a children's questionnaire using emojis. On the right: display board showing sticky notes with feedback or drawings created by the children.

In the primary school cohort, Q1 yielded a mean score of 3.23/5 (Table 1 and Fig. 3). High ratings (4-5) accounted for 44.44% of responses, while low ratings (1-2) represented 31.17%. For perceived learning (Q2), the primary school cohort recorded a mean score of 3.89/5. The share of high ratings reached 73.61%, indicating a strong perception of learning after the activity. Workshop appreciation was also high: Q3 yielded a mean score of 3.81/5, with 69.35% of responses in the top two categories. In the middle school cohort (Table 1 and Fig. 3), baseline knowledge (Q1) was lower overall, with a mean score of 2.70/5. Only 30.06% of responses fell in the 4-5 range, while 50.92% were in the 1-2 range. Perceived learning (Q2) nevertheless remained positive: high ratings represented 47.21% of responses, suggesting that the workshop was considered educationally valuable even among older students. Appreciation of the workshop was likewise favourable, as Q3 yielded 52.68% of high ratings.

Table 1. Summary comparison of questionnaire responses between primary and middle school students. N = total number of student respondents. Values in the mean columns are reported as mean +/- SD.

Question	Primary school				Middle school				Mean Difference
	N	Mean +/- SD	4-5%	1-2%	N	Mean +/- SD	4-5%	1-2%	
Q1. Prior topic knowledge	369	3.23 +/- 1.37	44.4	31.2	489	2.70 +/- 1.45	30.1	50.9	0.53
Q2. Perceived learning	288	3.89 +/- 1.27	73.6	14.6	430	3.14 +/- 1.53	47.2	35.6	0.75
Q3. Enjoyment of the workshop	447	3.81 +/- 1.37	69.4	20.1	429	3.35 +/- 1.51	52.7	30.1	0.47

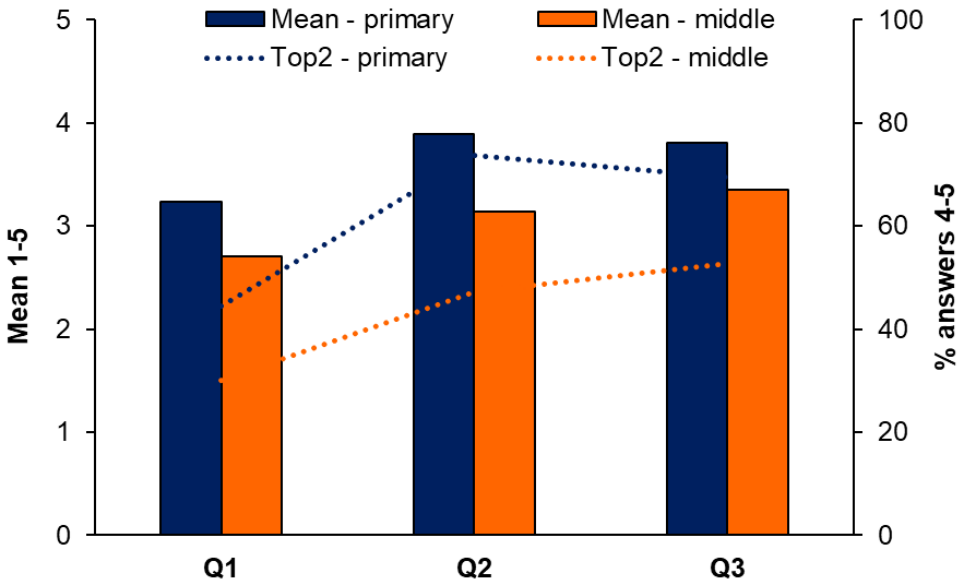


Fig. 3. Comparative overview of primary and middle school responses: mean scores and percentage of high ratings (4-5). Q1 = "Before this workshop, how much did you know about DNA?"; Q2 = "How much do you think you learned from this workshop?"; Q3 = "How much did you enjoy the workshop?".

Primary school pupils' scores were higher than middle school students' scores in all areas (Table 2 and Fig. 4). All differences were statistically significant ($p < 0.001$). The largest gap was observed for perceived learning (Hedges' g = 0.53), followed by initial knowledge and enjoyment. Comparing the mean values of Q1 and Q2 showed an average perceived gain of +0.66 points for primary school pupils and +0.44 points for middle school pupils. Thus, the workshop appeared to encourage perceived learning in both groups; however, it was perceived as more effective among primary school pupils, considering the greater variability observed among older participants.

Table 2. Statistical evidence for the comparison between school levels. Chi-square p and Top-2 p refer to between-group comparisons. Cramer's V quantifies the strength of distributional differences; Hedges' g quantifies the standardized mean difference.

Question	Chi-square p	Cramer's V	Top-2 p	Hedges' g
Q1. Prior topic knowledge	<0.001	0.207	<0.001	0.37
Q2. Perceived learning	<0.001	0.27	<0.001	0.525
Q3. Enjoyment of the workshop	<0.001	0.179	<0.001	0.324

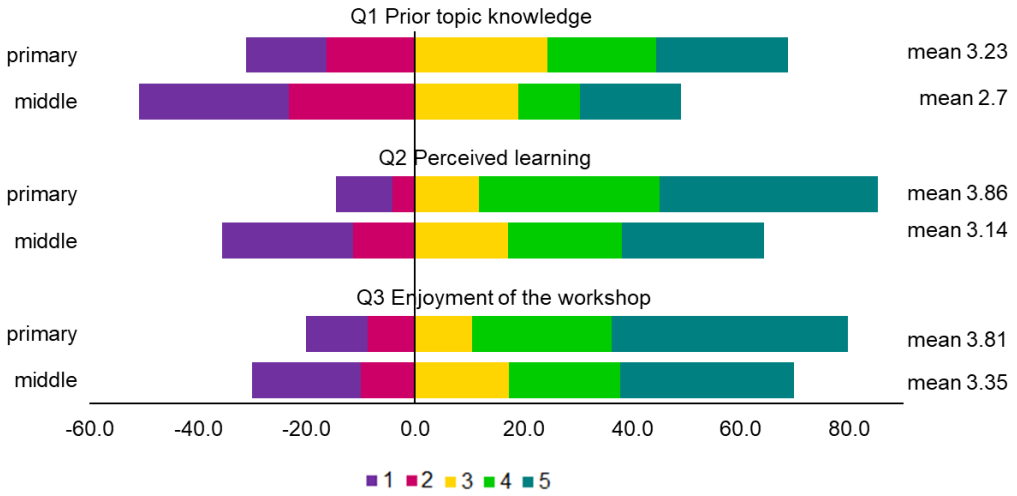


Fig. 4. Diverging stacked bar charts comparing the distribution of questionnaire responses between primary and middle school pupils for the three items: prior topic knowledge (Q1), perceived learning (Q2), and enjoyment of the workshop (Q3). Mean scores are reported for each group.

It is worth noting that participants' baseline knowledge levels differed (Table 1; Q1). Primary school pupils showed greater familiarity with the workshop topic, whereas middle school students generally rated their knowledge as lower. This may indicate a more rigorous self-assessment among older participants. Despite this, in both cohorts Q1 produced lower means than Q2 and Q3, suggesting that the workshop focused on a subject with which many participants were initially less familiar. Nonetheless, they still reported substantial perceived learning and enjoyment after the experience (Fig. 4).

Each teacher filled out an individual questionnaire to assess the game from an instructional standpoint (N = 66 primary school teachers; N = 87 middle school teachers). Feedback was also obtained via a 5-point Likert scale, enabling structured and systematic collection of expert evaluations. The questionnaire included four core questions assessing teachers' evaluation of the workshop in terms of overall satisfaction, contribution to the development of interest in science, and support for understanding the scientific topics proposed to young participants. Teachers were additionally invited to indicate what worked in the workshop in terms of content, methodologies, and communication methods, and to respond to an open-ended question about other relevant aspects from their perspective. This design facilitated the collection of both quantitative and qualitative data, thereby supporting a more comprehensive evaluation of the programme's feasibility and of the influence of the game on the development of essential competencies.

The teachers' questionnaire data (Table 3) indicate an overall positive evaluation of the workshop across both school levels. The most favourable ratings concerned the perceived educational value of the workshop for understanding the DNA replication process, together with the practical component, indicating that the hands-on format was the most appreciated element. Primary school teachers gave a mean score of 4.05 for interest in science, 4.11 for perceived support in understanding DNA, and 4.18 for satisfaction with the practical part. Among middle school teachers, the corresponding means were 3.87 for interest in science, 4.00 for support in understanding DNA, and 3.99 for the practical part. Between-group differences between primary and middle school teachers were assessed using Welch's t-tests, with Hedges' g reported as a measure of standardized mean difference (Table 3). Overall, differences between the two teacher cohorts were small, suggesting that the workshop was perceived positively and broadly consistently across both educational levels.

Table 3. Teachers' evaluation of the workshop by school level. Values are reported as mean +/- SD, percentage of ratings 4-5, percentage of maximum ratings, mean difference, Hedges' g, and Welch's p-value. Welch's p-values refer to between-group comparisons between primary and middle school teachers. n.a. = not available

Indicator	Primary school		Middle school		Mean Difference	Hedges' g	Welch's p
	Mean±SD	% 4–5	Mean±SD	% 4–5			
Interest in science	4.05±0.90	74.2%	3.87±0.71	70.1%	0.17	0.21	0.204
Helpfulness in understanding	4.11±0.83	80.3%	4.00±0.72	74.7%	0.11	0.14	0.406
Satisfaction with theoretical part	3.76±0.86	57.6%	3.72±0.82	60.9%	0.03	0.04	0.808
Satisfaction with practical part	4.18±0.88	75.8%	3.99±0.86	77.0%	0.19	0.22	0.174
What worked: content	3.85±0.81	65.2%	3.82±0.76	70.1%	0.03	0.04	0.801
What worked: methodologies	4.00±0.93	72.7%	3.94±0.87	72.4%	0.06	0.06	n.a.
What worked: communication style	3.97±0.93	68.2%	3.99±0.75	75.9%	-0.02	-0.02	0.893

Within each teacher cohort, ratings for the practical component were significantly higher than ratings for the theoretical component (Wilcoxon signed-rank test: primary schools, $p < 0.001$; middle schools, $p = 0.005$). This supports the interpretation that the workshop was judged most effective when scientific explanation was embedded in an interactive, hands-on activity. The items referring to what worked in the workshop also showed favourable ratings, particularly for methodology and communication style, which were close to 4 in both groups. Qualitative feedback from the open-ended questions highlighted play, hands-on engagement, and physical movement as the most valued elements of the workshop. Teachers emphasised the importance of active involvement and experiential learning, suggesting that these components enhanced both comprehension and retention of the scientific concepts presented.
In conclusion, the positive feedback collected suggests that participants reported high satisfaction with the learning experience. The format appears particularly well calibrated for primary school pupils, who showed higher levels of engagement, appreciation, and perceived learning (Fig. 5). At the same time, teachers' evaluations were highly positive and broadly consistent across primary and middle school levels.

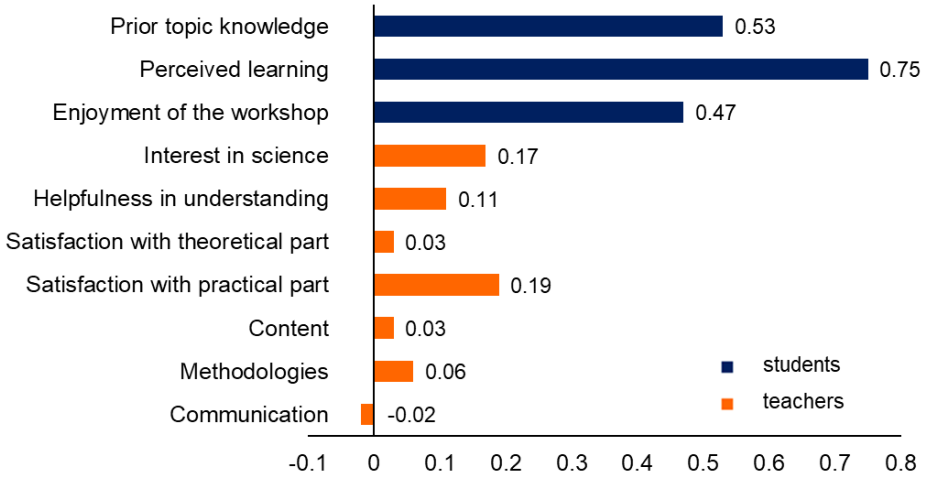


Fig. 5. Differences between primary and middle school ratings across questionnaire domains, expressed as the mean score in primary school minus the mean score in lower secondary school. Blue bars represent pupils' responses and orange bars represent teachers' evaluations.

Conclusions

During the 2025 edition of the Genoa Science Festival, we proposed the "Dancing with DNA" workshop. As the festival attracts a diverse audience with varying socio-economic and cultural backgrounds, the findings offer a degree of generalisability to broader educational contexts. Therefore, a primary strength of this educational case study lies in the breadth and heterogeneity of the sample. The workshop relies on a kinaesthetic learning approach and combines storytelling with visual elements and cooperative gaming. This methodology was designed to spark curiosity and interest in science among young people while simultaneously promoting soft skills through an engaging and enjoyable hands-on experience. This was supported by the facilitators' qualitative observations and by the feedback collected through interactive posters and questionnaires, which highlighted high levels of engagement and interest in the topics covered. The active modelling of DNA replication was successful in introducing DNA-related concepts and the spatial organisation of the cell to learners with heterogeneous prior knowledge, as well as in encouraging active participation and integration into group dynamics. The results suggest that this workshop may be suitable for supporting the development of basic scientific understanding of DNA and cell replication, integrating educational aims with an enjoyable play-based activity. While the findings resonated with both young participants and teachers, the data suggest that the format is currently best calibrated for primary school pupils, who reported higher levels of appreciation and perceived learning. Feedback from middle school students suggests that the format may require further refinement for this age group. This discrepancy likely stems from their more advanced cognitive baseline and different expectations regarding interactive learning.

Overall, this case study suggests that a gamification-based approach is feasible and promising as an educational tool for science communication and school-based science education. Further studies using pre-post designs and objective learning measures would be needed to quantify learning gains more robustly.

The proposed approach uses appropriate yet simple materials, making the educational activity well suited for inclusion within school curricula. We successfully proposed the workshop in standard classroom settings. Indeed, the activity is featured in the "Mappa della Citta Educante" of the Municipality of Rome, a catalogue that offers a variety of free educational activities to schools of all levels across the city.

Acknowledgements

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Early-Warning Prediction of Student Housing Dissatisfaction to Support Targeted University Interventions

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Abstract

Student housing dissatisfaction can erode wellbeing and academic engagement, but universities often learn about serious problems only after complaints escalate. We present a leakage-aware early-warning approach that predicts serious housing dissatisfaction from a lightweight student housing survey while excluding items that directly paraphrase the target outcome. Using a University of Koblenz survey (N=158), we define an at-risk case as an overall housing experience score of 3 or lower on a 1–5 scale (51/158, 32.3%). We compare Logistic Regression, Random Forest, histogram-based gradient boosting and a compact MLP under 5-fold stratified cross-validation. Random Forest achieves the strongest discrimination (ROC-AUC = 0.803 ± 0.127), closely followed by Logistic Regression (0.792 ± 0.096). Because student support teams operate with limited outreach capacity, we move beyond headline accuracy and examine threshold policies that translate predicted probabilities into concrete workloads. At the selected operating points, Random Forest and Logistic Regression identify 38 of 51 at-risk students while flagging 64–66 students for follow-up. Permutation importance highlights expectation alignment, affordability pressure, housing instability, privacy and space limitations, and service responsiveness as the most actionable signals. The study contributes a practical blueprint for survey-based triage that links prediction, threshold selection, explainability and ethical safeguards for targeted university support.

Keywords: *early-warning systems, student housing, targeted support, explainable machine learning, threshold policies, learning analytics*

1. Introduction

Housing conditions structure students' everyday capacity to study. A room that is unaffordable, noisy, overcrowded or poorly maintained can reduce sleep quality, limit concentration and make participation in campus life more difficult. These pressures are not always visible to the university, especially when students avoid formal complaints or normalize difficult living conditions until problems become severe. Most universities therefore face a timing problem. Complaints, crisis appointments and end-of-term surveys often arrive too late for preventive support, while student services must still decide which cases deserve attention first. An early-warning signal is useful only when it is operationally realistic: it should rely on information that can be collected early, avoid label leakage from questions that directly encode the outcome, and produce decisions that match available outreach capacity.

This paper develops and evaluates such a workflow on a small institutional housing survey. We benchmark four compact tabular models, report cross-validated predictive performance, and show how decision thresholds transform risk scores into concrete support workloads. We then use model-agnostic explanations to connect risk to intervention levers, so that the output is not a black-box label but a transparent triage aid for student services. The study is guided by three research questions: **RQ1:** *To what extent can non-leaky housing survey features identify students at risk of serious housing dissatisfaction?* **RQ2:** *How do different probability thresholds change the balance between missed at-risk students and feasible outreach workload?* **RQ3:** *Which interpretable risk signals can inform support actions without reducing the model to a black-box decision tool?*

The contribution is deliberately practical and operational. First, the paper defines a leakage-aware prediction task that excludes direct satisfaction summaries from the feature set. Second, it reports not only discrimination metrics but also threshold-dependent workload indicators that a student support unit can understand. Third, it links global explanations to non-punitive support pathways, so that predictions serve as prompts for outreach rather than as labels attached to students.

2. Background and Related Work

Housing has been associated with mental health, stress and academic engagement, especially when students face affordability pressure or unstable arrangements [1,2]. These mechanisms motivate early support: if a university can identify severe dissatisfaction early, it can route students to information about contracts and rights, mediation with providers, emergency options or maintenance escalation before problems compound. Parallel work in learning analytics and early-alert systems shows that predictive models can help target support, but operational details matter as much as discrimination metrics [3-5]. In small-data institutional settings, interpretable models and clear decision policies are often preferable to complex pipelines. We therefore emphasize leakage-aware feature design, transparent thresholding and post-hoc explanations, aligning with applied machine learning guidance on cost-sensitive decision making [5,6].

This article is part of a broader line of analyses using the Koblenz student-housing survey, but it addresses a different operational question. Prior same-dataset work examined affordability and accessibility through geospatial and regression indicators [7], choice scarcity and spatial equity through mixed methods and geographically weighted regression [8], and recurring need profiles through Bernoulli latent class analysis [9]. The present paper does not reuse those analytical framings as its contribution. It instead asks whether early survey signals can be converted into a workload-aware triage policy for targeted support. Accordingly, the outcome, modelling task, validation emphasis and decision logic are distinct from those earlier studies.

Early-warning models also raise two design questions: how to communicate risk scores responsibly and how to convert them into action. In education, this conversion is often hidden behind a default threshold such as 0.5. The best operating point depends on the relative cost of missed severe dissatisfaction, unnecessary outreach, staff availability and the consequences of being flagged [6,10]. We therefore report both discrimination and workload-facing metrics, treating the threshold as a policy parameter rather than a purely technical choice.

3. Data and Problem Formulation

We use a cross-sectional student housing survey conducted at the University of Koblenz (N=158). The instrument includes demographic and study context, housing characteristics, search and moving history, decision factors, service responsiveness, perceived fit and overall housing experience. The survey was designed for institutional insight rather than high-stakes classification, which makes it a realistic test case for low-burden early warning.

The prediction task is binary classification. A respondent is labelled at-risk if the overall housing experience score is 3 or lower on a 1–5 Likert scale (51/158; 32.3%). This threshold captures clearly negative or ambivalent experiences where outreach is plausibly warranted. To avoid label leakage, we remove survey items that directly summarise satisfaction or overall experience. The remaining features describe housing conditions and potential drivers of dissatisfaction, not the target itself.

For interpretation, features are grouped into five domains: affordability and financial strain, expectation and information alignment, service and maintenance experience, physical space and privacy, and stability or search history. This grouping supports communication with non-technical stakeholders and discourages over-interpretation of isolated questionnaire items. Class imbalance is moderate, so we rely on stratified validation and threshold tuning rather than aggressive resampling, which can be unstable in small samples.

4. Methods

Feature representation and preprocessing. Numerical variables such as room size, semester number and number of moves are used as numeric inputs. Ordinal Likert items are encoded with ordered integer scores; categorical variables are one-hot encoded. Missing values are imputed within the modelling pipeline using fold-consistent rules (median for numeric variables and mode for categorical variables) to avoid information leakage across folds.

Models. We benchmark four models that can be deployed without heavy infrastructure: Logistic Regression with L2 regularization, Random Forests [11], histogram-based gradient boosting and a compact multi-layer perceptron. The goal is not to maximise marginal gains, but to identify a model class that balances discrimination, stability and interpretability for institutional use.

Validation, metrics and threshold policies. We use 5-fold stratified cross-validation with shuffling and a fixed random seed (seed = 42). Discrimination is assessed with ROC-AUC, while operational

performance is assessed with precision, recall and F1. Because support services operate under capacity constraints, we tune the decision threshold within the cross-validation procedure and report deployment-style confusion matrices that make workload explicit: how many students are flagged, how many at-risk cases are found and how many are missed. These thresholds should therefore be interpreted as planning-oriented operating points for this survey wave, not as final deployment thresholds. A live system would require prospective validation on a later survey wave before routine use.

Probability calibration. Threshold policies rely on the numerical meaning of predicted probabilities, so discrimination alone is not enough. A model may rank students well while still over- or under-estimating absolute risk. Before deployment, predicted probabilities should therefore be checked with calibration diagnostics such as reliability plots or Brier score, and recalibration methods should be considered if probabilities are poorly calibrated [12]. In this paper, calibration is treated as a deployment requirement and not as evidence already established by the present sample.

Explainability. For the best-performing model, we compute permutation importance using ROC-AUC as the scoring function. This model-agnostic ranking identifies which variables most influence predictive performance and helps map risk signals to actionable responses. Logistic Regression coefficients provide a second, simpler interpretive check; in a future deployment, local explanation methods such as LIME and SHAP could support student-specific review [13,14].

5. Results

5.1 Predictive Performance

Table 1 reports mean performance across the 5-fold stratified validation and should be read in two ways: as a comparison of model discrimination and as evidence that the classification threshold materially changes operational performance. Random Forest provides the strongest discrimination (ROC-AUC = 0.803 ± 0.127) and the best threshold-tuned F1 (0.733). Logistic Regression follows closely (ROC-AUC = 0.792 ± 0.096, tuned F1 = 0.695), which means that the final model choice need not be based on accuracy alone.

Table 1. Model comparison under 5-fold stratified cross-validation. Recall reported here is the mean across folds at per-fold tuned thresholds. Pooled out-of-fold recall at fixed thresholds in Table 2 differs slightly

Model	ROC-AUC (mean ± sd)	F1 @0.5 (mean)	F1 tuned (mean)	Precision tuned (mean)	Recall tuned (mean)	Threshold (mean)
Random Forest	0.803 ± 0.127	0.635	0.733	0.708	0.802	0.40
Logistic Regression	0.792 ± 0.096	0.607	0.695	0.623	0.802	0.27
HistGB	0.767 ± 0.131	0.571	0.652	0.618	0.724	0.28
MLP	0.649 ± 0.116	0.379	0.551	0.435	0.800	0.29

.

The most important pattern in Table 1 is that threshold tuning improves F1 for every model compared with the default 0.5 threshold. This is expected in a support setting where the positive class is smaller than the negative class and where missed at-risk cases are operationally important. The tuned thresholds therefore determine how many students become visible to the support workflow. The table also shows a practical trade-off between marginal predictive gain and institutional transparency. Random Forest is the strongest performer, but Logistic Regression remains close enough to be a credible alternative if a university prioritises a simpler scoring rule for communication and review. By contrast, the MLP has lower ROC-AUC and F1 in this small tabular setting, so the results favour compact, interpretable or ensemble methods over a more complex neural baseline.

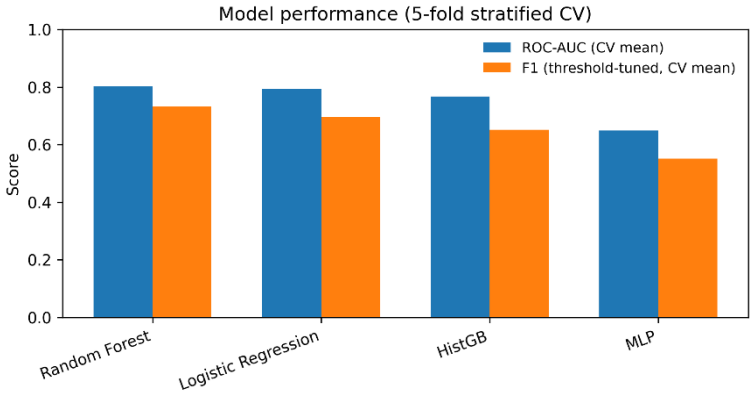


Fig. 1. Cross-validated performance summary. ROC-AUC reports discrimination, and threshold-tuned F1 reflects the per-fold optimal threshold.

5.2 Operational Thresholds and Workload

Accuracy alone does not determine whether an early-warning system is usable. The decision threshold determines how many students are routed to follow-up. Table 2 illustrates deployment-style confusion matrices at the selected thresholds (0.40 for Random Forest, 0.27 for Logistic Regression). At these settings, both models identify 38 of 51 at-risk students while flagging roughly 64–66 students in total. A support unit can move along this precision-recall trade-off by selecting a threshold that matches outreach capacity. Because Table 1 reports fold-level means at per-fold tuned thresholds whereas Table 2 reports pooled counts at fixed thresholds, the recall values differ slightly.

Table 2. Deployment-style confusion matrices and workload metrics at fixed thresholds.

Model (threshold)	TN	FP	FN	TP	Flagged (TP+FP)	Missed (FN)	Precision	Recall
Random Forest (0.40)	81	26	13	38	64	13	0.594	0.745
Logistic Reg. (0.27)	79	28	13	38	66	13	0.576	0.745

5.3 Interpretable Risk Drivers

Permutation importance for the Random Forest indicates that expectation alignment is the dominant signal, followed by affordability pressure, indicators of housing instability, privacy or space limitations and service responsiveness. This pattern points to concrete levers, including clearer listings and realistic photos, contract briefings, affordability guidance, emergency support and faster escalation for recurring maintenance issues.

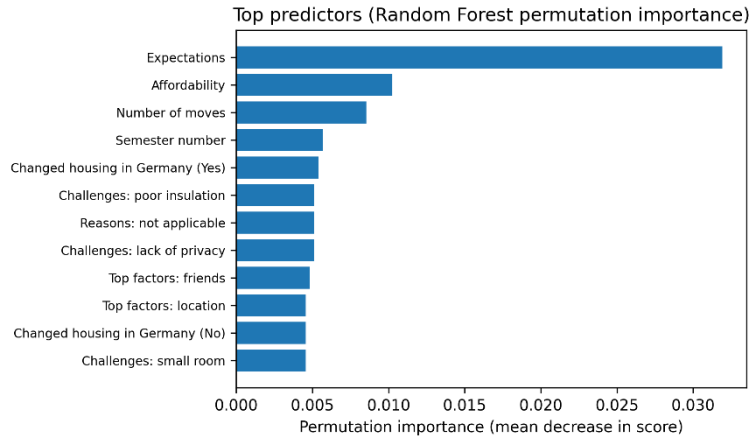


Fig. 2. Top predictors from Random Forest permutation importance (y-axis labels are survey item short names).

As a worked triage example, suppose a support unit can conduct 50 short check-ins in the next two weeks. The threshold can be calibrated to yield approximately 50 flagged students, prioritising the highest predicted risks while keeping workload feasible. Lowering the threshold would increase recall but require more outreach; raising it would reduce staff load but miss more at-risk students. This illustrates why thresholding should be treated as a governance decision rather than a fixed modelling default.

6. From Risk Scores to Responsible Outreach

The intended output of the model is not an automated decision, but a structured prompt for earlier support. Table 3 translates the modelling workflow into an institutional process that can be audited and adjusted. The table is deliberately framed as a support workflow: every step leaves room for human judgement, documentation and revision.

Table 3. Operational workflow for a leakage-aware housing early-warning process.

Step	Input	Decision point	Support-oriented output
1. Early survey	Short housing questionnaire	Exclude outcome-like satisfaction summaries	Leakage-aware feature set
2. Risk scoring	Preprocessed survey features	Apply trained model and record uncertainty	Ranked list of risk scores
3. Threshold choice	Current staff capacity and risk tolerance	Select threshold or top-k workload rule	Feasible flagged group
4. Triage review	Risk score plus global risk-driver information	Match support intensity to likely need	Information, check-in, mediation or escalation
5. Monitoring	Outreach outcomes and error patterns	Audit calibration, subgroup performance and workload	Revised threshold, survey items or workflow

6.1 Thresholds as Capacity Decisions

The same model can support different operating modes depending on the institutional situation. A lower threshold is appropriate when the priority is to miss as few severe cases as possible, while a higher threshold or top-k rule is appropriate when staff time is scarce. Table 4 describes policy choices that can be made without adding new model evidence or changing the underlying survey.

Table 4. Example threshold-policy choices for different support contexts.

Support context	Threshold logic	Priority metric	Reason
Start of semester or known housing pressure	Use a lower threshold	Recall	Avoid missing students whose problems may escalate quickly
Normal week with limited staff	Use a higher threshold or top-k list	Precision and workload	Keep outreach feasible and reviewable
Pilot deployment	Begin conservatively and manually review flagged cases	Trust and auditability	Test workflow before routine use
After additional survey waves	Recalibrate and revisit threshold	Calibration and stability	Check whether probabilities and workload remain reliable

6.2 Appropriate and Inappropriate Uses

The model should be used only to prioritise supportive contact. A flagged case should trigger an invitation to help, not an administrative label. A non-flagged case should not be interpreted as evidence that a student has no housing problem. The system should not be used to allocate scarce housing places, evaluate tenancy behaviour, penalise students or landlords, or replace normal access to support services. These restrictions are important because the target is self-reported dissatisfaction, the sample is small, and prediction errors are unavoidable.

6.3 Governance Checks Before Live Use

Before live deployment, the workflow should pass four checks. First, students should know that survey responses may be used to offer support and should understand what will not happen as a result of being flagged. Second, the model should be prospectively validated on a later survey wave, including calibration checks and subgroup error review. Third, staff should document the selected threshold, the capacity assumption behind it and the date of review. Fourth, outcomes of outreach should be evaluated qualitatively and quantitatively so that the system is judged by whether it improves support, not only by whether it predicts a survey label.

7. Discussion and Implications

The main design lesson is that prediction becomes educationally useful only when it is connected to a concrete service process. In this case, the model is best understood as a triage instrument. It helps identify students who may benefit from earlier contact, and the form of that contact remains a human support decision. The explanation profile matters because it connects risk scores to actions that the institution can take. Expectation alignment suggests the need for clearer pre-arrival information and more realistic accommodation descriptions. Affordability pressure suggests referral to financial counselling or emergency support. Maintenance and service signals suggest response-time standards, clearer reporting channels and escalation rules. In this way, the model output becomes a guide for practical support, not only a statistical result. Threshold selection is the point at which analytics becomes policy. The selected threshold reflects an institutional judgement about missed severe dissatisfaction, unnecessary outreach and available staff time. For that reason, the threshold should not be hidden inside the software pipeline. It should be documented, periodically reviewed and communicated to the team using the system [6,10].

Ethical safeguards are also methodological safeguards. Consent, data minimisation and separation between support and enforcement reduce the risk that students experience the system as surveillance. Error audits are equally important. False positives can create unnecessary concern, and false negatives leave students unsupported. Human review and transparent communication are therefore part of the validity of the intervention, not optional additions.

The study is limited by its small, single-institution and cross-sectional sample, and by a self-reported target label. The reported thresholds and confusion matrices are useful for planning, but they do not replace prospective validation. The present paper also does not estimate causal effects of outreach. It shows how risk can be identified and operationalised, but it does not test whether a specific intervention changes housing outcomes. Future work should validate the workflow across survey waves and universities, assess calibration before deployment, audit subgroup error patterns, and evaluate whether outreach improves housing conditions, wellbeing or engagement.

8. Conclusion

We presented an early-warning system that predicts serious student housing dissatisfaction from a lightweight survey and translates predictions into feasible outreach decisions through threshold policies. In this sample, Random Forest achieved the strongest discrimination. Logistic Regression remained close enough to be a plausible lower-complexity alternative when communicability, auditability and ease of recalibration matter. The broader methodological lesson is that small-data institutional settings require more than headline metrics. Models become more useful when discrimination, threshold-dependent workload and ethical safeguards are reported together. The workflow connects prediction to concrete support levers such as expectation management, affordability guidance and maintenance escalation. In this way, predictive analytics becomes a practical and auditable tool for student wellbeing, not an abstract score.

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Modeling and Analysis of Interventions Directed by Race and Gender of Students in the Mitigation of School Dropout in Brazil

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Abstract

The present study investigated the extent to which the student-student dimension of the Relational Factors for the Risk of School Dropout Scale [1] was able to track students at higher risk of dropping out of school based on their relationships with each other and how class, race, and gender markers [2] were determinant for risk analysis and prevention over the course of a year Synthetic data was generated using the Gaussian Copula technique, which estimates new responses based on the correlation between the observed variables in the real dataset, reproducing its relationships. Due to ethical considerations and compliance with Brazilian data protection legislation (LGPD), this study relies on synthetic, anonymized data, however, a nationwide data collection using real-world data is currently being conducted in Brazil. This approach was considered due to the General Law of Data Protection (LGPD). Results reflect that the use of interventions based on Psychology and Critical Pedagogy have an effect on reducing the risk of school dropout as well as promoting well-being [3] in this environment and quality for the teaching and learning process as showed in the state case [4]. In the end, it is proposed to link the measure to its intersectional analyses, which consider racism, sexism and ableism as important tools in the fight against school dropout when we think of a country of continental proportions and as diverse in numerous factors as is the case of Brazil.

Keywords: *school dropout, large scale analysis, gender, race, school dropout prevention*

1. Introduction

Early school dropout is a multifaceted and persistent challenge, with profound implications not only for individual trajectories, but also for public health, economic development, and social equity [1]. Historically, approaches to mitigate this phenomenon have focused on traditional early warning metrics, such as the ABC typology based on Frequency, Behavior Incidents, and Course Performance [2]. Although useful, these indicators often fail in primary prevention, as they only identify the problem when the student is already in an advanced process of leaving school, ignoring the complex web of structural and contextual factors that motivate school dropout [2].

To overcome these limitations, public policies have been proposed that aim at more systemic perspectives on school dropout. It is in this scenario that the Relational Model (MR) and the Instrument for the Assessment of Risk Factors for School Dropout (IAFREE) stand out, which propose an in-depth analysis of interpersonal dynamics in the school context [1] [2]. IAFREE tracks vulnerabilities through five interrelated dimensions: Student-School, Professional School Students, Family-Student, Student Community, and Student-Student [5]. The model understands that school dropout is not an isolated event or a purely individual failure, but the result of interactional failures and a school environment that often cannot accommodate the diversities and needs of its students [2].

The socioeconomic dimension plays an undeniable role in the failure of students in the educational system, given that the dynamics of contemporary capitalism require more sophisticated analyses. Recent studies have revealed a paradox in Brazilian public schools: from the point of view of "flexible capitalism", the increase in family income may also be associated with a higher risk of dropping out of school [3]. This is because the precarious labor market and the promises of immediate financial gains end up devaluing the school as a significant space for the construction of life projects [3]. In addition, recent educational reforms, such as the New Brazilian Secondary School, are often overtaken by market logics that deepen educational inequality. By focusing on a disjointed and class-based vocational

education, these policies run the risk of acting as tools of a "State Racism", where education functions as an instrument of segregation, condemning young people from the popular classes to underemployment and naturalizing inequalities [4].

1.1 Prejudice in Brasil

It is impossible, therefore, to analyze school dropout in Brazil without an intersectional lens that highlights the markers of race-ethnicity and gender. Racism, as a structural, intrinsic, and multifaceted phenomenon of Brazilian society, directly impacts the subjectivities and trajectories of black students [5]. The school, which should be a welcoming space, often acts as a hostile environment, where discriminatory practices, stigmas and recreational racism (the use of humor to propagate prejudiced violence) are repeated daily [5]. The ideology of whitening and the myth of racial democracy mask this violence, forcing young black people to deal with rejection, invisibility, or stereotyped visibility in teaching materials and social interactions [5].
At the same time, gender inequalities and sexism consolidate significant barriers to school retention and success. Gender relations are socially constructed from belief systems that promote the superiority of normative heterosexuality and hegemonic masculinity [6] [7]. At school, these norms translate into microaggressions, machismo, LGBTQIAPNbphobia and the imposition of restricted social roles, which negatively affect students' mental health and engagement [6] [8]. Exclusionary language and the naturalization of stereotypes (such as the false idea that women do not belong in the field of exact sciences) limit girls' aspirations and reinforce symbolic violence [7] [8].
For the school to act as a protection institution, it is essential to anchor educational practices and research in references that value listening and the dignity of vulnerable populations. Black Feminist Epistemology, by proposing the valorization of lived experience, orality, the ethics of care and personal responsibility, offers a robust methodological path [9]. This framework teaches us that listening to students, validating their experiences intersected by racist and sexist discrimination, is not only an act of research, but a political gesture of emancipation and pain that avoids revictimization and promotes social justice [9].

1.2 The Current Study

In view of this complex web of vulnerabilities, the present study investigates to what extent the Student-Student dimension of the IAFREE scale can track students at higher risk of dropping out based on their interpersonal relationships. More than mapping interactions, the study seeks to examine how race-ethnicity and gender markers are determinants in risk analysis and in the formulation of prevention strategies over the course of an academic year.
To ensure analytical rigor combined with the ethical commitment to privacy protection, in strict compliance with the General Data Protection Law (LGPD) of Brazil, this work adopted an innovative methodology based on the generation of synthetic data using the Gaussian Copulation technique. This method estimates new responses based on the correlations observed in the real data set, allowing for safe and effective simulation of large-scale interventions.
Through this modeling, the research demonstrates that interventions based on Psychology and Critical Pedagogy have a proven effect on reducing the risk of dropout, promoting the well-being and quality of the teaching-learning process. By linking the measurement of dropout risk to intersectional analyses, we argue that the fight against racism and sexism are not marginal agendas, but rather structural tools indispensable for the definitive mitigation of school dropout in a country of continental proportions and deep inequalities such as Brazil.

2. Method

A quantitative, cross-sectional, descriptive-comparative design was adopted, based on synthetic data modeling. We analyzed patterns of vulnerability to school dropout based on the relational dimensions of the Instrument for the Assessment of Risk Factors for School Dropout – Alternative Version (IAFREE-A), with emphasis on social markers of sex and race-ethnicity. The quantitative design with synthetic data allowed us to examine population patterns of school vulnerability, preserving the correlational structure of the original database and, at the same time, ensuring greater protection of student’s privacy.

2.1 Ethics

The generation of synthetic data was adopted as a strategy to mitigate ethical risks, especially in relation to the preservation of privacy, the minimization of the exposure of individual information, and compliance with the General Law for the Protection of Personal Data (LGPD – Law No. 13,709/2018). Thus, no directly identifiable individual data was used in the analyses presented.

2.2 Participants

The database was composed of 10,000 synthetic cases of students, generated to preserve the statistical structure of an original educational base, maintaining patterns of association between variables without exposure of individually identifiable data. For the present analysis, the variables Sex and Race-Ethnicity were considered.
Regarding gender, the total database had 4,898 students classified as male (49.09%), 5,082 as female (50.91%). Considering the inclusion criteria defined for this study, only the cases classified in the binary categories male and female were maintained, resulting in an analytical sample of 9,980 students. The distribution indicates a proportional balance between the two groups, which favors statistical comparisons between males and females, reducing the risk of significant sample asymmetries.
Regarding the Race-Ethnicity variable, the sample presented three categories. The white category gathered 2,079 students (20.83%), the brown category gathered 2,295 students (23.00%) and the black category gathered 5,606 students (56.17%). Therefore, it is observed that category 3 predominates in the racial-ethnic composition of the sample, which already alerts us to the racial profile of public school students in Brazil.

3. Results

The analysis was conducted based on the corrected IAFREE-A scores. According to the calculation manual, all items of the instrument should be inverted, except for items Q5 and Q36, so that higher scores indicate greater vulnerability or greater need for attention to the school trajectory. The results were interpreted based on the five relational dimensions of the instrument, axes of protection and vulnerability related to school permanence, allowing a relational reading of the risk of dropout.

3.1 Gender Analysis

Table 1 shows the mean dimensional scores of the IAFREE-A by gender. In all dimensions, male students had higher averages than female students, indicating greater perceived vulnerability to school dropout.

Table 1. Mean IAFREE-A 46 dimensional scores by sex

Dimension	Male	Male	Female	Female
	M	SD	M	SD
Student – School	2,70	0,35	2,64	0,35
Student – School Professionals	3,02	0,40	2,99	0,40
Student – Family	2,84	0,41	2,79	0,42
Student – Community	2,89	0,34	2,82	0,35
Student – Student	2,85	0,56	2,67	0,57

The differences between the male and female groups were statistically significant in all dimensions. Considering the large sample size, the interpretation prioritized effect sizes. The greatest difference was observed in the Student-Student dimension (d = 0.31), followed by Student-Community (d = 0.19), Student-School (d = 0.16), Student-Family (d = 0.13) and Student-School Professionals (d = 0.07).
This pattern suggests that the difference by sex is more relevant in the dimensions linked to school belonging, peer relationships, educational expectations, and school-community integration. The Student-Student dimension is central to the study, as it allows us to trace how interpersonal relationships in everyday school life can act as protective or vulnerable factors for dropout. Our analysis situates school dropout as a relational phenomenon and not as an individual failure of the student.

Table 2 presents the percentage of students classified as high vulnerability in each dimension, considering the universal normative cut-off points of IAFREE-A.

Table 2. Percentual de vulnerabilidade por sexo

Dimension	Male	Female
Student – School	**96,45%**	**94,59%**
Student – School Professionals	51,16%	44,57%
Student – Family	51,18%	38,57%
Student – Community	42,02%	36,97%
Student – Student	90,10%	88,27%

The Student-Community dimension presented the highest percentages of high vulnerability in both sexes: 96.45% among male students and 94.59% among female students. High scores in this dimension indicate that students capture important weaknesses in the relationship between school and community, including low territorial integration, insecurity, conflicts between school and community values, and difficulties in articulating with external protection networks.

The second most critical dimension was Student-School Professionals, with 90.10% of high vulnerability among male students and 88.27% among female students. This result indicates a largely unfavorable perception of the relationships with teachers, management, coordination and other school professionals. High scores in this dimension express difficulties in dialogue, welcoming, institutional collaboration, teacher expectations and pedagogical quality.

The most substantive difference between the sexes appears in the Student-Student dimension. While 51.18% of male students were classified as highly vulnerable, this percentage was 38.57% among female students. This difference suggests that male students in this database have greater fragility in peer relationships, school belonging, social skills and expectations regarding education. From the psychosocial point of view, this finding can be interpreted in the light of processes of socialization of masculinities, interpersonal conflicts, less adherence to care practices, and greater subjective distance from school.

3.2 Racial Analysis

Table 3. Means of the IAFREE-A dimensional scores by race-ethnicity.

Dimension	White	Brown	Black
Student – School	2,67	2,67	2,67
Student – School Professionals	3,00	2,99	3,01
Student – Family	2,82	2,81	2,81
Student – Community	2,84	2,85	2,86
Student – Student	2,75	2,75	2,77

The averages were quite close between the three race-ethnicity categories. The comparative analyses indicated the absence of statistically relevant differences in the dimensions Student-School, Student-School Professionals, Student-Family and Student-Student. In the Student-Community dimension, there was a statistically significant difference, but with practically zero effect size ($\eta^2 = 0.0007$), indicating low practical relevance.

Table 4. Percentage of vulnerability by race-ethnicity

Dimensão	White	Brown	Black
Student – School	47,62%	47,28%	48,09%
Student – School Professionals	89,37%	88,37%	89,42%
Student – Family	40,12%	39,52%	39,17%
Student – Community	94,61%	95,51%	95,83%
Student – Student	44,73%	43,75%	45,18%

The Student-Community dimension showed high vulnerability above 94% in all race-ethnicity categories, with a higher percentage in the Blacks category (95.83%). Suggesting that the fragility in the articulation between school, community and protection network is a transversal axis of the sample, crossing all racial-ethnic groupings.
The Student-School Professionals dimension also presented extremely high percentages in all categories: 89.37% in the White category, 88.37% in the Brown category and 89.42% in the Black category. Pedagogical and institutional relations constitute a general critical point for school permanence.
The Student-Student dimension presented percentages between 43.75% and 45.18%, with a slight increase in the Blacks category. Although the difference between the categories is small, this dimension remains theoretically important because it is directly connected to school belonging, peer acceptance, subjective recognition, and expectations for the future.

4. Discussion

As seen, vulnerability to school dropout is organized mainly around institutional, community and relational dimensions, and not only around individual characteristics of students. This finding supports the central premise of the IAFREE Relational Model, dropout should be understood as a phenomenon produced in the interaction between everything that makes up the school. We were able to shift the analysis from late indicators, such as attendance and performance, to psychosocial and contextual factors that precede school dismissal.
The Student-Community dimension showed the highest levels of high vulnerability in all groups analyzed by race-ethnicity and sex-gender, suggesting fragility in the articulation between school, territory and protection networks. The school cannot be thought of as an isolated institution, but as part of a broader social ecosystem. When the school does not activate support services, does not establish community partnerships or does not dialogue with the concrete living conditions of students, its protective capacity is reduced. Preventing dropout requires intersectoral actions involving education, social assistance, health, culture, security, family and community.
The Student-School Professionals dimension, with high levels of vulnerability. He pointed to problems perceived in the relationship with teachers, management and other professionals, involving pedagogical quality, institutional communication, teacher expectations and welcoming. Regarding school permanence, the results are relevant because learning does not depend only on formal access to school, but on the quality of pedagogical and institutional interactions that sustain engagement. When students perceive low teacher expectations, unresponsive pedagogical practices or fragile institutional relationships, the school tends to lose its function of recognition and protection.
The sex-gender breakdown showed greater vulnerability among male students in all dimensions, especially in Student-Student, involving interpersonal relationships, social skills, belonging, identification with the school and expectations regarding education. This suggests that students may be more exposed to forms of socialization that hinder the expression of vulnerability, the construction of care bonds and the non-violent mediation of conflicts. Preventive interventions should, therefore, consider masculinities, school life, belonging and life project as central axes, avoiding interpretations that individualize or pathologize boys.
In the cut by race-ethnicity, the dimensional means were close among all regardless of being White, Brown or Black, the high transversal vulnerability should not be interpreted as the absence of racial inequalities. Structural racism, sexism, and other forms of discrimination permeate the Brazilian school experience, affecting recognition, belonging, and permanence. Even when the average differences are small, racialized reading remains necessary, especially in the dimensions related to community, relationships with professionals, and interactions between students.

4.1 Limitations

Although it preserves correlational patterns from the original database and is adequate to protect the privacy of students, the results should not be interpreted as definitive population estimates. The synthetic base allows simulating trends, testing models and guiding interventional hypotheses, but it does not replace analyses with empirical data collected directly in real school contexts.
Another limitation concerns the use of the male-female binary category, which limits the understanding of the experiences of trans, non-binary students and other gender identities. In addition, the race-ethnicity variable was analyzed in three aggregated categories, which may reduce sensitivity to capture specificities among white, brown, black, indigenous, and yellow students. Considering that the

theoretical model of the study itself emphasizes racism, sexism and structural inequalities as fundamental dimensions of school dropout.

4.2 Proposals

It is recommended that schools strengthen intersectoral networks with social assistance, health, guardianship council, community collectives, cultural facilities and territorial organizations, since the community dimension presented high vulnerability in all groups analyzed. It is also proposed to invest in critical, anti-racist and anti-sexist teacher training, qualification of pedagogical practices, improvement of institutional communication and creation of protocols to confront discrimination, bullying, racism, sexism and LGBTQIAPNb+phobia.
The results indicate the need for specific actions aimed at school belonging, peer relationships, masculinities, conflict mediation and the construction of positive educational expectations, especially among male students. It is also recommended that IAFREE-A be incorporated as a preventive and non-punitive screening tool, allowing schools to identify relational dimensions of risk before dropout occurs. Its application should be linked to collective intervention plans, qualified student listening, longitudinal monitoring and continuous evaluation of the effects of the actions implemented, avoiding the use of the instrument to label students and prioritizing its function of protecting school trajectories.

5. Final Considerations

School dropout should be understood as a relational, structural, and intersectional phenomenon, produced by the articulation between social inequalities, institutional weaknesses, precarious community bonds, and school experiences marked by recognition or exclusion. In this sense, confronting dropout requires more than monitoring attendance, behavior, and performance: it requires a school capable of listening, welcoming, and transforming the conditions that make students vulnerable. In dialogue with bell hooks, it is understood that education must be a practice of freedom, sustained by care, listening and ethical commitment to historically marginalized subjects. In the same way, in Paulo Freire, school permanence can only be thought of from a critical, dialogical and emancipatory pedagogy, capable of recognizing students as historical subjects and not as objects of intervention.

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Prediction of Students Performance Based on School Dropout Risk Factors

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Abstract

School dropout has been widely recognized as a complex and multifactorial phenomenon, with significant implications for both individual development and educational systems. In recent years, advances in early warning systems have sought to anticipate this risk by identifying factors associated with school disengagement, particularly those of a relational nature, such as interactions among students, families, and schools [1]. Study aimed to investigate the predictive effect of school dropout risk factors on the performance of Brazilian students, using a synthetic sample of 10,000 cases, derived from a real dataset of 3,678 students from four states of Brazil. Synthetic data was generated using the Gaussian Copula technique, which estimates new responses based on the correlation between the observed variables in the real dataset, reproducing its relationships. Due to ethical considerations and compliance with Brazilian data protection legislation (LGPD), this study relies on synthetic, anonymized data, however, a nationwide data collection using real-world data is currently being conducted in Brazil. This approach was considered due to the General Law of Data Protection (LGPD). Results show that the relationships of students with family, other students, and school professionals' impacts on school performance. Results indicated that the pedagogical quality (p=.004), parenting (p<.001), support structure at home (p<.001), coordination with the family (p=.048), and belonging (p<.001) impact students' performance. These findings reinforce the central role of relational dimensions in shaping students' academic outcomes, highlighting that school performance is not solely determined by individual or structural factors, but emerges from the quality of interactions within the educational ecosystem. Overall, results provide empirical support for the advancement of early warning systems that incorporate relational indicators, contributing to more sensitive, context-aware, and effective strategies to prevent school dropout.

Keywords: *School dropout, Large-scale analysis, Educational psychology*

1. Introduction

School dropout has been widely recognized as a complex and multifactorial phenomenon, with profound implications for both individual development and the structuring of educational systems. The advancement of early warning systems has sought to anticipate this risk by identifying factors associated with school disengagement, overcoming purely individualistic views to focus on relational dimensions [1]. Understanding these interpersonal and institutional dynamics is fundamental for the design of more assertive public policies and for the promotion of a protective educational ecosystem that addresses the root causes of performance inequalities.

In order to capture the complexity of these interactions in different intergroup contexts, the use of robust and ecologically valid psychometric instruments is essential. Assessment models have been developed and improved, structuring risk and protective factors in various dimensions of student life. The refinement of these measures, as observed in the adaptations of the Relational Factors Scale for the Risk of School Dropout in its revised and alternative versions [2],[3] allows for the multivariate mapping of specific vulnerabilities that permeate the student's relationship with school professionals, their family structure, the local community and their peers.

Despite the urgency, contemporary empirical research faces the challenge of balancing investigative rigor with ethical privacy guidelines; therefore, handling educational microdata from vulnerable populations requires innovative approaches. A methodological alternative to the generation of synthetic data has emerged as a promising methodological solution, using techniques such as Gaussian Copula

[4],[5] to reproduce the relationships and distributions of the original data [6], preserving the statistical integrity necessary for inferential analyses without compromising the anonymity of the participants.
Advances in the formulation of early warning systems have challenged strictly individualistic explanatory models, highlighting that the risk of academic disengagement emerges from vulnerabilities intrinsic to the relational networks in which the individual is immersed, particularly in the interactions established with the school ecosystem and the family nucleus. The investigative gap that guides the problematization of this work therefore lies in the need to measure the predictive effect of these psychosocial risk factors on the concrete performance of students.
Given the above, an assessment of the level of international vulnerability was conducted using the Alternative Version of the Scale of Relational Factors for the Risk of School Dropout (IAFREE-A). The analytical approach focused on examining the extent to which these relational dimensions statistically differentiate students with normative trajectories from those who have already experienced grade repetition. Through non-parametric inferences for independent groups, our hypothesis is that the history of academic failure is linked to weaknesses in interactions, constituting an expression of broader socio-educational disinvestment.

2. Method

2.1 Participants

The participants were students enrolled in public schools in four Brazilian states, comprising an original dataset of 3,678 individuals, collected as part of the School Trajectory Protection System (SPTE), a Brazilian initiative aimed at protecting students' educational trajectories. From this original dataset, a synthetic sample of 10,000 cases was generated, in which females predominated (50.82%), students concentrated in the Midwest region (44.35%), and 9,536 (95.4%) were classified as non-repeaters and 458 (4.6%) as repeaters (Table 1).

Table 1.

Sex	n	%	Race/Ethnicity	n	%
Male	4898	48.98	White	2168	21.68
Female	5082	50.82	Black	2062	20.62
I prefer not to declare	20	0.20	Brown	5488	54.88
			Other	282	2.82
Region of Brazil	n	%	Failure history	n	%
Midwest	4435	44.35	Repeaters	458	4.60
Northeast	1368	13.68	Non-repeaters	9536	95.40
North	1625	16.25			
Southeast	2572	25.72			

Characteristics of the participants' sociodemographic background.

2.2 Instruments

The final version of the Relational Factors for the Risk of School Dropout Scale – Alternative Version (IAFREE-A) [3] is an adaptation of the instrument originally developed by [1] (IAFREE) and revised by [2] (IAFREE-R), structured based on the concept of School Trajectory Protection. The instrument, completed by students, consists of 46 items organized into five protective relational dimensions: Student–School (SSc), Student–School Professionals (SP), Student–Family (SF), Student–Community (SC), and Student–Student (SSt). These dimensions are distributed across 14 factors of attention: Infrastructure (SSc1), School as a Safe Space (SSc2), Discrimination (SSc3), School Management and Organization (SP1), Pedagogical Quality (SP2), Teachers' Expectations (SP3), Parenting (SF1), Family Support Structure (SF2), Family Interaction (SF3), Network Interaction (SC1), Community Relations (SC2), Interpersonal Relations and Social Skills (SSt1), Expectations Regarding Education/Educational Development (SSt2), and Belonging/Identification (SSt3). Responses are recorded on a four-point Likert scale, presented in two formats: frequency ("Never" to "Always") and agreement ("Strongly Disagree" to "Strongly Agree"), both accompanied by pictorial cues. For most items, the scoring is reversed, with the exception of Q5 and Q36, which are phrased negatively. Thus, higher scores indicate a greater need for attention to academic progress, while lower scores indicate a lower degree of vulnerability. To characterize the participants' profiles, a 33-item sociodemographic questionnaire was also administered, covering variables such as gender, race/ethnicity, and history of failing grades, among others.

2.3 Procedures

Data collection was conducted in operational cycles, which provide schools with two options for administering the IAFREE-A: a digital version, accessible via a platform integrated into tablets and computers, and a printed version, intended for institutions with limited or unstable internet connectivity. In this context, students from schools belonging to four state school systems located in the Central-West, Northeast, North, and Southeast regions of Brazil participated in the study. The research was conducted in accordance with ethical guidelines for studies involving human subjects, as per Resolutions No. 466/2012 and No. 510/2016 of the National Health Council, and was approved by the Human Research Ethics Committee (CEP/UFAL), under opinion No. 5.407.594. Furthermore, all procedures related to the collection, storage, and processing of information followed the principles established by the National Council of Ethics in Research (CONEP) and the provisions of the General Data Protection Law (LGPD) [7], ensuring confidentiality, anonymity, and protection of participants throughout the entire research process.

2.4 Data Analysis

The analyses were performed using the R programming language [8], employing the Gaussian copula technique to generate synthetic data. Based on copula theory, this method allows for the modeling of multivariate distributions by separating the marginal distributions from the dependency structure among the variables [4] [9], generating new synthetic observations from integral probability transformations applied to real data [5]. Among its main advantages is the preservation of associations between variables in the database, maintaining the functional equivalence of synthetic data for inferential purposes [10], a relevant aspect in psychometric studies, in which latent factors are derived from correlations between items [11]. Thus, the similarity between the real and synthetic data was assessed using the Hellinger distance, an indicator ranging from 0 to 1, where values close to 0 represent greater similarity between the distributions [6], with values up to 0.20 considered adequate.

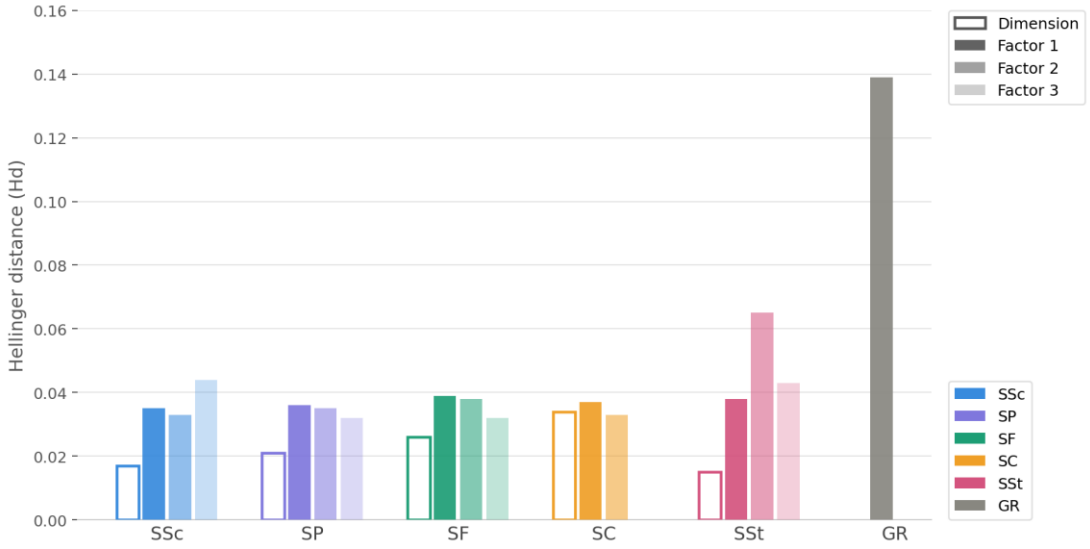
Based on this, the aim was to examine whether, and to what extent, the relational factors of the IAFFREE-A differentiate students according to their academic performance trajectory, specifically with grade repetition. Thus, group differences were operationalized by forming two groups defined by academic performance history: students who had never failed a grade (non-repeaters) and students who had repeated at least one school year (repeaters), measured using a single dichotomous self-report item: "Have you ever failed a grade?", to which participants responded with (0) "No, I have never failed" or (1) "Yes, at least once." This binary classification served as the independent variable, while the scores on the dimensions and factors of the IAFREE-A constituted the dependent variables of interest.

The differences were examined using the Mann–Whitney U test (also known as the Wilcoxon rank-sum test; [12] [13], a nonparametric procedure suitable for comparing two independent groups when the distributional assumptions of parametric tests cannot be met. Thus, the magnitude of group differences

was estimated using the rank-based biserial correlation (r) as a measure of effect size for the Mann–Whitney U test [14]. Effect sizes were classified according to [15] as small (|r| ≥ 0.10), medium (|r| ≥ 0.30), and large (|r| ≥ 0.50). All comparative statistical analyses were conducted using JASP [16].

3. Results

The quality of the correspondence between the synthetic data and the original data was assessed using the Hellinger distance (Hd), a measure ranging from 0 to 1, where values closer to zero indicate greater similarity between the distributions analyzed. In this regard, all values obtained remained below the established adequacy criterion (Hd < 0.20), demonstrating high similarity between the distributions of the synthetic and original data.
As shown in Figure 1, the Hd values ranged from 0.015 (SSt) to 0.034 (SC). At the factor level, a slightly more significant range of variation was observed, with values between 0.032 (SP3 and SF3) and 0.065 (SSt2), all remaining within the limits considered satisfactory, which corroborates the quality of the approximation achieved. As for the sociodemographic variable, Grade repetition recorded Hd = 0.139, a value that, although higher than the others, remained below the adopted cutoff point, possibly due to the marked imbalance in the distribution of this variable in the original sample, characterized by a low proportion of students repeating a grade, a condition that tends to increase the complexity of its synthetic reproduction compared to variables with more balanced distributions.



Note. Hd: Hellinger distance. Colors indicate dimension: Darker shade = Factor 1; medium shade = Factor 2; lighter shade = Factor 3; outlined bar = Dimension. GR = Grade Repetition. SSc: Student–School; SP: Student–School Professionals; SF: Student–Family; SC: Student–Community; SSt: Student–Student.

Fig. 1. Hellinger distance by dimension, factor, and grade repetition.

The results of the Mann-Whitney test indicated statistically significant differences between students who had repeated a grade and those who had not across seven variables in the questionnaire (Table 2). Students with a history of grade repetition reported more negative perceptions regarding family support, family involvement, school belonging, and interpersonal relationships compared to those who had never repeated a grade. The most significant differences were concentrated particularly in dimensions related to family dynamics and identification with the school, indicating that grade repetition is not limited solely to low academic performance but is also associated with broader relational vulnerabilities that permeate students' school trajectories.
As for students who had to repeat a grade, the results showed higher means for the factors SF1 (M = 1.983; SD = 0.578), SF2 (M = 1.911; SD = 0.569), SF3 (M = 2.427; SD = 0.694), SSt2 (M = 1.718; SD = 0.492), in the SF dimension (M = 2.114; SD = 0.485), and in the SSt dimension (M = 2.099; SD = 0.525). The concentration of differences in the factors of the SF dimension indicates that the family context is the most sensitive domain to the pattern of academic failure, suggesting that students who repeat a grade perceive less support, less structure, and more distant family interactions regarding school life. The difference in SSt2, in turn, indicates that these students also have lower expectations regarding their own educational development, which may reflect a process of progressive disengagement from their school trajectory and academic performance.

With regard to students who did not repeat a grade, higher means were observed only for factors SP2 (M = 2.307; SD = 0.584) and SF3 (M = 2.491; SD = 0.660). The result for SP2 suggests a more critical assessment of pedagogical quality by these students, given their greater engagement with the learning process; conversely, the difference in SF3 warrants interpretive caution, given the trivial effect size observed.

In this regard, effect sizes ranged from trivial to small, with small effects observed in SF1 (r = .125), SF2 (r = .113), and SSt2 (r = .154), while SP2 (r = −.070), SF3 (r = −.058), SF (r = .071), and SSt (r = .064) showed magnitudes below the cutoff point for a small effect. Among the variables analyzed, SSt2 showed the most significant effect size, although still of small magnitude, suggesting that students' expectations regarding their own educational trajectory constitute the relational factor with the greatest discriminative power between the groups.

Table 2. Mann–Whitney comparison tests: school dropout risk factors and the performance of Brazilian students.

Variables	Groups	Mean	SD	*U*	*p*	Effect Size
SP2 – Pedagogical quality	*1 = "No, I have never repeated"*	2.307	0.584	2.912	.009	−.070
	2 = "Yes, at least once"	2.226	0.556			
SF1 – Parenting	*1 = "No, I have never repeated"*	1.858	0.569	-4.611	<.001	.125
	2 = "Yes, at least once"	1.983	0.578			
SF2 – Home support structure	*1 = "No, I have never repeated"*	1.799	0.575	-4.067	<.001	.113
	2 = "Yes, at least once"	1.911	0.569			
SF3 – Engagement with the family	*1 = "No, I have never repeated"*	2.491	0.660	1.978	.034	−.058
	2 = "Yes, at least once"	2.427	0.694			
SSt2 – Belonging / Identification	*1 = "No, I have never repeated"*	1.589	0.487	-5.511	.001	.154
	2 = "Yes, at least once"	1.718	0.492			
SF - Student-Family	*1 = "No, I have never repeated"*	2.054	0.494	-2.539	.010	.071
	2 = "Yes, at least once"	2.114	0.485			
SSt - Student-Student	*1 = "No, I have never repeated"*	2.033	0.523	-2.637	.021	.064
	2 = "Yes, at least once"	2.099	0.525			

Note. SD = Standard Deviation. *U* = Mann–Whitney U test statistic. Effect Size = rank-biserial correlation. $p < .05$.

4. Discussion

As demonstrated, the family microsystem plays a central role in structuring trajectories of academic vulnerability [1]. The concentration of statistically significant differences in structural support factors at home and in parenting highlighted how grade repetition goes beyond strictly individual cognitive deficits, becoming the outcome of broader relational deprivations for students. The family, therefore, acts as the most sensitive domain in relation to the pattern of school failure. For the formulation of public policies, we indicate that the design of systems to protect school trajectories must transcend intra-classroom barriers, requiring integrated socio-educational strategies that foster the structuring and engagement of the family unit.

Regarding intergroup relations and institutionalization, belonging and identification with the school revealed discriminatory power among student profiles. Students with a history of grade repetition reported significantly lower expectations regarding their own educational development, as well as more negative perceptions about their belonging to the school environment. This pattern illustrates the

crystallization of a progressive disengagement process, in which distancing from normative support networks reinforces the phenomenon of exclusion. The mitigation of exclusionary interpersonal dynamics and the strengthening of intergroup cohesion in the school climate thus emerge as crucial vectors to ensure that academic performance is supported by quality protective interactions.
Counterintuitively, we note that students with academic records free from failing grades reported more critical perceptions regarding the pedagogical quality offered by the institution. This dynamic suggests that greater engagement with the learning process refines the student's evaluative criteria, turning them into a more demanding observer of the infrastructure and teaching practices. Adherence to and success in the educational system presuppose an active demand for excellence and continuous support, challenging educational management to constantly refine its institutional approaches to meet the needs of highly engaged students.

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Understanding University–Industry Engagement through Challenge-Based Learning: Evidence from Industry Perspectives

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Abstract

Universities are increasingly expected to contribute to innovation, sustainability, and regional development alongside their traditional missions of education and research. Challenge-Based Learning (CBL) has emerged as a pedagogical approach that connects students, higher education institutions, and external stakeholders through student engagement with real-world challenges. While prior research has predominantly examined the effects of CBL on student learning and skill development, limited attention has been given to its outcomes for industry and organizational partners acting as challenge providers. This study addresses this gap by exploring how regional actors perceive their participation in CBL and whether such collaboration supports meaningful university–industry engagement. Using a qualitative exploratory research design, semi-structured in-depth interviews were conducted with six organizations from diverse sectors that collaborated with a university through CBL projects. The interview data were thematically analyzed to identify perceived benefits, outcomes, and challenges associated with CBL collaboration. The findings indicate that CBL provides organizations with access to new perspectives, supports reflection on organizational practices, and contributes to early-stage problem exploration and innovation processes. At the same time, challenges related to time constraints, feasibility of student-generated solutions, flexibility of the collaboration model, and variability in student motivation were reported. Despite these limitations, all participating organizations assessed the overall value of CBL collaboration positively, emphasizing its long-term potential for knowledge exchange, relationship building, and future collaboration. The study contributes to research on university–industry collaboration by providing empirical insights from the perspective of external stakeholders and by positioning CBL as a pedagogical approach that can create mutual value beyond student learning, supporting the broader societal role of higher education institutions.

Keywords: *Challenge-Based Learning, University–Industry Collaboration, Student Engagement, Knowledge Exchange, Higher Education*

1. Introduction

Universities are increasingly expected to contribute not only to education and research but also to broader societal and economic development. In response to technological change, sustainability challenges, and evolving innovation demands, higher education institutions have expanded their role within regional and innovation systems through activities associated with the “third mission,” including knowledge exchange and external collaboration [1]. Within this context, university–industry engagement has gained importance as a mechanism for facilitating collaboration, innovation, and interaction between academic institutions and external organizations. Collaboration between universities and industry enables the exchange of expertise, resources, and practical knowledge that can support both educational and organizational development. Universities contribute research capabilities and access to emerging talent, while industry partners provide practical contexts and real-world challenges that can enrich learning processes and collaborative activities [2], [3].

These interactions have increasingly extended into educational settings through experiential and challenge-oriented learning approaches that connect students with real-world problems and external stakeholders [4]. As a result, universities are increasingly adopting more integrated models that combine education, research, innovation, and societal engagement [5].

One pedagogical approach associated with these developments is Challenge-Based Learning (CBL). CBL involves students in collaborative engagement with real-world challenges through interaction with peers, educators, and external actors, linking academic learning to applied problem solving [6]. Previous studies have primarily examined CBL in relation to student learning and experiential engagement with

real-world challenges. However, comparatively less attention has been given to the perspectives of industry partners and external stakeholders involved in these collaborations [4], [7].
This study addresses this gap by examining how organizations perceive their participation in Challenge-Based Learning and how such collaboration contributes to university–industry engagement. More specifically, the study explores the perceived benefits, outcomes, and challenges experienced by regional actors involved in student-driven CBL projects. Using a qualitative exploratory design based on semi-structured interviews with industry partners, the study provides empirical insight into how CBL may support interaction, collaboration, and knowledge exchange between universities and external stakeholders [2], [8].
The paper contributes to research on higher education and collaborative learning by extending discussion of CBL beyond student-centered outcomes and situating it within broader debates on university–industry collaboration. In doing so, it highlights the potential role of students as participants in collaborative knowledge exchange processes and emphasizes how pedagogical approaches may support the evolving societal role of universities.

2. Literature Review and Theoretical Framework

2.1 University–Industry Collaboration in Higher Education

University–industry collaboration (UIC) describes interactions between higher education institutions and external organizations that facilitate the exchange of knowledge, expertise, and technology [9]. Increasing technological complexity and competitive pressures have contributed to the growing importance of these collaborations, particularly as organizations seek access to external knowledge and innovation networks [10], [11].
Alongside these developments, universities have faced increasing expectations to contribute more directly to economic and societal development. This has strengthened the emphasis on external engagement and positioned universities more prominently within regional innovation systems and knowledge-transfer activities [12], [3].
UIC encompasses a range of collaborative activities, including joint research, knowledge exchange, and educational partnerships. Through these interactions, industry partners gain access to academic expertise and research capabilities, while universities benefit from engagement with practical challenges and applied contexts [13]. Governments have also encouraged university–industry interaction as part of broader innovation and economic development strategies [14].
More recently, collaboration between universities and industry has increasingly extended into educational settings through internships, student projects, and collaborative supervision models [15], [2]. These forms of engagement connect students with external stakeholders and support practice-oriented learning experiences that extend beyond traditional research partnerships [2].

2.2 Experiential Learning and Challenge-Based Learning

The involvement of external stakeholders in educational activities reflects a broader shift toward experiential and practice-oriented learning approaches in higher education. These approaches emphasize active participation, collaborative problem solving, and the application of knowledge within real-world contexts [6], [4]. Through collaboration with external actors, students engage with practical challenges that extend learning beyond traditional classroom settings. Such interactions may also expose organizations to alternative perspectives and forms of collaborative knowledge exchange. In addition, collaborative and practice-oriented activities involving regional actors may strengthen relationships between universities and their surrounding communities [16], [17]. At the same time, engagement with external stakeholders can help connect educational activities more closely with real-world challenges and societal needs [4].
One pedagogical approach associated with these developments is Challenge-Based Learning (CBL). CBL is a collaborative pedagogical approach that connects academic learning with real-world challenges and applied problem-solving activities. Developed through Apple's initiative, the approach emphasizes active participation, interdisciplinary collaboration, and engagement with authentic problems. The CBL framework is commonly structured around three phases—engage, investigate, and act—through which students explore challenges and develop responses to complex issues [6], [8]. CBL has also been associated with the evolving societal role of universities by supporting competencies such as collaboration, critical thinking, and interdisciplinary problem solving [18].

Because CBL frequently involves collaboration with external stakeholders, it can also strengthen connections between universities, industry, and society through engagement with applied and sustainability-related challenges [19]. In addition to supporting student learning, these collaborative activities may also provide organizations with access to new perspectives and collaborative knowledge exchange processes [3], [2].
Prior research on university–industry collaboration and CBL highlights three key dimensions: organizational experience, benefits, and challenges. Benefits include access to knowledge and innovation, while challenges relate to time constraints and feasibility [2], [3], [20]; interaction patterns further shape how organizations experience these collaborations [15].

2.3 Research Gap

Although previous studies have examined CBL primarily as a higher-education learning approach and have emphasized student learning, competencies, and collaboration with industry and community actors, comparatively less attention has been given to the perspectives of external stakeholders themselves [7], [4].
This study addresses this gap by examining how industry partners perceive their participation in CBL and how they evaluate the benefits and challenges associated with such collaboration. By focusing on the experiences of regional actors, the study contributes to understanding CBL not only as a pedagogical strategy but also as a collaborative mechanism within university–industry engagement.

3. Methodology

3.1 Research Design

This study adopts a qualitative exploratory research design to examine how industry partners perceive their participation in Challenge-Based Learning (CBL). A qualitative approach is appropriate for exploring the experiences, perceptions, and reflections of organizations involved in collaborative educational processes and university–industry interaction [21].
The study is guided by the following research question: How do organizations perceive the benefits and challenges associated with participation in Challenge-Based Learning collaborations?

3.2 Data Collection

Data were collected through semi-structured interviews with six organizations that participated as challenge providers in CBL projects. These organizations collaborated with the University of Stavanger and ECIU University initiatives and represented diverse sectors, including innovation, financial services, consulting, and sustainable development (Table 1). Additional respondent and organizational details are not reported at the individual level to preserve anonymity.
A purposive sampling strategy was used to recruit participants with direct experience in university–industry CBL collaboration. Interviews were conducted via Microsoft Teams in May 2023 and lasted between 20 and 35 minutes. All interviews were recorded and transcribed for analysis. Selection criteria included organizations that had participated in CBL collaborations with the University of Stavanger and individuals directly involved as challenge providers.

Table 1. Overview of interview participants and organizations
Source: Adapted from [22]

Code	Field of Activity	Date	Duration	Platform
CO1	Sustainable city development	03.05.2023	20 minutes	Microsoft Teams
CO2	Innovation	12.05.2023	35 minutes	Microsoft Teams
CO3	Financial services	16.05.2023	20 minutes	Microsoft Teams
CO4	Innovation	15.05.2023	24 minutes	Microsoft Teams
CO5	Autonomous solution	08.05.2023	20 minutes	Microsoft Teams
CO6	Business consulting	05.05.2023	20 minutes	Microsoft Teams

3.3 Data Analysis

The data were analyzed using thematic analysis. Interview transcripts were coded iteratively to identify recurring patterns and themes related to organizational experiences, perceived benefits, and challenges associated with CBL collaboration.
Thematic analysis followed an iterative coding process in which transcripts were read repeatedly to support familiarization with the data and identify recurring patterns in participants' descriptions of collaboration experiences. Initial codes were progressively grouped into broader thematic categories through comparison across the six cases, allowing common patterns and variations between organizational perspectives to be identified and refined.
The identified outcomes were grouped into themes such as access to knowledge, efficiency, reciprocity, and organizational reflection. Challenges were categorized into time constraints, feasibility, flexibility, and student motivation.

3.4 Ethical Considerations

Ethical guidelines were followed throughout the study, including informed consent and anonymization of participants. The study was approved by the relevant data protection authority.

4. Results And Discussion

4.1 Benefits and Outcomes of CBL Collaboration

The findings indicate that participation in Challenge-Based Learning (CBL) generate multiple forms of value for industry partners (Table 2). The most frequently reported outcome is access to new knowledge and perspectives, with four out of six organizations emphasizing the benefit of student contributions in approaching challenges from alternative viewpoints. This suggests that CBL can support exploratory thinking and idea generation within organizations, particularly during the early stages of problem identification.
A second key outcome is organizational reflection. Rather than producing immediately implementable solutions in all cases, CBL prompted companies to reassess internal processes, decision-making approaches, and strategic directions. Some participants reported that student contributions encouraged reconsideration of existing practices and assumptions, highlighting the role of CBL in facilitating reflection and dialogue within organizations. This finding aligns with broader perspectives on university–industry collaboration, which emphasize knowledge exchange and collaborative relationships between universities and industry partners [2].
In addition, participants identified benefits related to efficiency and human capital development. Student involvement supported preliminary analysis and idea generation, reducing the need for internal resource allocation. In some cases, participation also created opportunities for continued engagement and future collaboration (e.g., CO6), indicating the potential of CBL to support longer-term university–industry relationships. Similar patterns have been discussed in university–industry collaboration literature emphasizing knowledge exchange and collaborative relationships between universities and external organizations [3].
These findings suggest that the value of CBL lies not only in tangible outputs but also in cognitive and organizational effects, particularly reflection, learning, and collaborative interaction.

Table 2. Outcomes/Benefits of CBL collaboration for industry

Outcomes/Benefits	CO1	CO2	CO3	CO4	CO5	CO6	Cited frequency	Cited frequency (n=6) (%)	Most frequent (>60%)
Strategic institutional policy				X			1	17	
Access to students for internship or hiring					X		1	17	
Shortening product life cycle				X			1	17	
Human capital development	X	X			X		3	50	
Access to new knowledge	X	X	X	X			4	67	X
Solutions to specific problems	X	X	X		X		4	67	X
Access to research networks					X	X	2	33	

Source: Adapted from [22]

4.2 Challenges of CBL Collaboration

Despite these benefits, several challenges were identified (Table 3). The most significant limitation is time constraints, as organizations reported that the duration of a single academic semester is often insufficient for in-depth analysis and implementation. This highlights a structural mismatch between academic timelines and organizational expectations.
A second challenge concerns the feasibility of student-generated solutions. While student contributions were often creative, some organizations found them difficult to implement due to practical or resource-related constraints. This was particularly evident in cases where proposed solutions did not align with operational realities (e.g., CO3), reflecting the tension between exploratory learning processes and organizational implementation requirements.
Participants also noted issues related to flexibility and alignment. For example, some organizations expressed concern that the structured nature of CBL limits adaptability when challenges evolve over time (e.g., CO1). In addition, variability in student motivation and communication was identified as a factor influencing the quality of collaboration, with some participants reporting inconsistent levels of engagement. Similar implementation-related challenges have been discussed in previous CBL research, particularly in multidisciplinary and practice-oriented learning environments [20]. These findings suggest that while CBL facilitates interaction between universities and industry, its effectiveness depends on alignment between project design, organizational expectations, and student engagement.

Table 3. Challenges of CBL collaboration for industry
Source: Adapted from [22]

Challenges	CO1	CO2	CO3	CO4	CO5	CO6	Cited frequency	Cited frequency (n=6) (%)	Most frequent (>60%)
Time constraints	X	X					2	33	
Flexibility	X						1	17	
Feasibility			X				1	17	
Student motivation	X		X				2	33	
Lack of communication				X			1	17	

4.3 Balancing Benefits and Limitations

Across all cases, organizations generally perceived the benefits of CBL as outweighing its limitations, particularly when evaluated from a long-term perspective. Participants recognized that CBL is embedded within an educational context and therefore assessed its value not only in terms of immediate outputs but also in relation to future collaboration, knowledge exchange, and recruitment opportunities. Importantly, the perceived value of CBL was influenced by the scale and nature of the challenge. Smaller, well-defined problems were more likely to produce actionable outcomes, whereas broader challenges tended to generate conceptual insights and reflective value. Some participants emphasized that large or complex challenges resulted in useful perspectives rather than direct solutions, while more focused tasks allowed for more tangible outcomes.
These findings indicate that the effectiveness of CBL depends on careful alignment between challenge scope, stakeholder expectations, and the structure of the learning process. This is consistent with previous CBL research emphasizing the importance of challenge design, collaboration, and structured learning processes within practice-oriented environments [8].

5. Conclusion and Implications

5.1 Conclusion

This study examined the role of Challenge-Based Learning (CBL) in university–industry collaboration by focusing on the perspectives of organizations acting as challenge providers. The findings indicate that participation in CBL may generate value for industry partners primarily through access to new knowledge and perspectives, support for early-stage problem exploration, and opportunities for organizational reflection. While these outcomes do not always lead to directly implementable solutions, they contribute to broader learning and collaborative processes within organizations [2], [3].

At the same time, several challenges were identified, including time constraints, feasibility of student-generated solutions, and variability in student engagement. These challenges reflect structural differences between academic contexts and organizational expectations. Despite these limitations, all participating organizations perceived the overall value of CBL positively, particularly from a long-term perspective related to knowledge exchange and future collaboration.
Overall, the findings highlight the dual role of CBL as both a pedagogical approach and a collaborative mechanism that supports interaction between universities and external stakeholders.

5.2 Theoretical Implications

This study contributes to the literature on university–industry collaboration by extending the understanding of Challenge-Based Learning beyond its traditional focus on student learning outcomes. While previous research has primarily emphasized educational benefits, the present study highlights the role of CBL as a mechanism for collaborative knowledge exchange and interaction between universities and industry partners [4], [7].
By focusing on the perspectives of external stakeholders, the study provides empirical insight into how CBL can facilitate organizational reflection and early-stage innovation processes. The findings also emphasize the role of students as active contributors to knowledge exchange, aligning with broader perspectives on collaborative and practice-oriented learning environments [6], [8].
In this way, the study positions CBL as an integrative approach that connects education, collaboration, and innovation, contributing to the evolving societal role of higher education institutions.

5.3 Practical Implications

The findings offer practical insights for both universities and industry partners involved in CBL initiatives. For universities, the results highlight the importance of designing clearly defined and manageable challenges that align with both educational objectives and organizational needs. Structured coordination, clear communication, and alignment of expectations are essential to enhance collaboration effectiveness.
For industry partners, participation in CBL can provide access to new perspectives, support exploratory thinking, and create opportunities for engagement with future talent. However, organizations should view CBL primarily as a process that supports reflection, learning, and idea development, rather than immediate implementation of solutions.
Furthermore, the findings suggest that the effectiveness of CBL depends on the scope and complexity of the challenge. Smaller and well-defined challenges are more likely to result in actionable outcomes, while broader challenges tend to generate conceptual insights and support strategic reflection [8].

5.4 Limitations and Future Research

This study has several limitations. First, the empirical sample is limited to six organizations, which may affect the transferability of the findings. Second, the study is conducted within a specific collaborative context, which may limit generalizability to other settings. Additionally, the findings rely on self-reported perceptions, which may introduce subjective bias.
Future research could extend this study by including a larger and more diverse sample across different industries and geographical contexts. Further studies could also incorporate perspectives from additional stakeholders, such as students and academic staff, to provide a more comprehensive understanding of CBL as a collaborative approach. In addition, quantitative or mixed-method research designs could be applied to assess the broader impact of CBL on university–industry collaboration outcomes.

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APPENDIX A

INTERVIEW GUIDE

1. Warming up/Engagement questions:
    - Introduction of researchers, supervisor, co-supervisor, topic, and main question of the research
    - Asking the interviewees to introduce their organization (challenge provider), professional background, title, and date of CBL program, their role, and tasks in the CBL
    - Terminological clarifications: CBL (challenge-based learning), UIC (university industry collaborations), etc.
    - Explaining different stakeholders/actors of CBL: industry, educational part (academia and students), and society
2. Exploration of present aspects:
    - How did you identify the challenge? Was it a predefined challenge or did CBL learners help you to recognize it? Ask follow-up questions about the limitations/facts while finalizing the challenge.
    - Tell us more about your experience in CBL as a challenge provider. What was the motive behind engaging in a CBL collaboration?
    - Tell us more about the exchange of resources on the company side.
    - What were the benefits/outcomes of CBL for you at an institutional level? Asking follow-up questions to be able to categorize the benefits in one of the main groups
    - What were the benefits/outcomes of CBL for you on an individual level? Asking follow-up questions to be able to categorize the benefits in one of the main groups
    - What were the negatives of CBL for you on an institutional level? Asking follow-up questions to be able to categorize the benefits in one of the main groups
    - What were the negatives of CBL for you on an individual level? Asking follow-up questions to be able to categorize the benefits in one of the main groups
    - What is your thought or plan with the solution you have got from the students?
    - All in all, do you think the benefits outweigh the negatives?
3. Exploration of future aspects and exit questions:
    - What could be done to improve the negatives and increase the positive outcomes
    - Would you or your organization prefer to participate in CBL going forward?
    - Summarization and asking if any other point remains to be mentioned?

Thank you very much for your time indeed

Active Learning in a School-Based Innovation Ecosystem: An Experience Report from Colégio Donaduzzi at Biopark Educação (Brazil)

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Abstract

Recent evidence from international educational research indicates that active learning methodologies, including cooperative and experiential learning approaches, demonstrate statistically significant correlations with academic achievement, learner motivation, and student engagement across educational levels when compared to traditional teaching methods [1]. Systematic literature reviews further indicate that such approaches lead to improved educational outcomes and are associated with greater knowledge retention and academic performance, particularly when supported by appropriate pedagogical design and effective technological integration [1,2]. This paper reports on the innovative pedagogical practices implemented at Colégio Donaduzzi, an educational institution operating within the Biopark ecosystem in Toledo, Brazil. Situated in a context that integrates formal education, research, and technological innovation, the school adopts active and experiential learning strategies, interdisciplinary project work, and personalized learning pathways as core elements of its educational model. These practices are supported by collaborative learning environments, a bilingual program, formative assessment processes, individualized mentoring, the possibility of customizing learning pathways outside regular class hours to support personalized education, and the use of digital technologies and artificial intelligence to assist learning progression.The institutional model is unique, while inspired by dialogue and knowledge exchange with educational approaches from Finland, the United States, and Portugal, enabling the translation of globally researched practices into the local school context. Preliminary institutional evidence indicates that this approach has translated into measurable outcomes, including strong student participation in scientific projects and consistent performance in national academic competitions, such as sustainability, robotics and language challenges. Drawing on institutional observations and aligned with current international evidence on active methodologies, this experience illustrates how relationally structured and inquiry-driven educational practices can foster deeper engagement, autonomy, and academic resilience.

Keywords: *Personalized learning; Student engagement; Innovation ecosystem; Educational innovation.*

1. Introduction

Active learning has become a central paradigm in contemporary education in response to the demand for learning environments that foster student engagement, autonomy, and meaningful knowledge construction. Methodologies such as project-based learning, collaborative learning, gamification, and inquiry-based approaches have been associated with improvements in academic performance, student motivation, and persistence across educational levels [1]. Empirical and systematic studies indicate that these strategies enhance participation, autonomy, and problem-solving engagement when compared to traditional lecture-based teaching models, contributing to more consistent learning outcomes and sustained student involvement in the learning process [1,2]. Research also shows that student engagement is shaped not only by instructional methods but by institutional environments, collaborative cultures, and classroom dynamics. Learning contexts that integrate participatory pedagogies, interaction, and formative feedback tend to promote stronger and more sustained engagement and learning continuity [2,3]. Although the theoretical and empirical literature on active learning has expanded substantially, its translation into everyday school practices remains uneven, particularly in basic education. Schools frequently face structural, pedagogical, and organizational constraints that limit the systematic adoption of innovative approaches. This scenario reinforces the relevance of studies that document and analyze concrete institutional experiences situated in innovation-oriented educational environments [4].

Innovation ecosystems have been increasingly recognized in educational research as relevant contexts for transformation, particularly when they integrate schools, universities, research initiatives, and technological infrastructures in collaborative arrangements that connect theory and practice and support adaptive learning models and innovation-driven pedagogies [5,6].
Colégio Donaduzzi is a basic education institution that began its operations in January 2025, initially serving students in the final years of elementary education and upper secondary education within the Biopark innovation ecosystem. In 2026, it offered the complete cycles of elementary and upper secondary education. The school is a non-profit educational initiative maintained by Biopark Educação, a civil society organization dedicated to education, research, and innovation. The institution is certified as a charitable educational entity by the Brazilian Ministry of Education and holds public utility recognition at both the state level of Paraná and the municipality of Toledo. This institutional structure supports the integration between schooling, technological development, and interdisciplinary learning environments.
During its first year of operation, the school implemented a pedagogical model grounded in active learning, interdisciplinary projects, individualized mentoring, bilingual exposure, and digitally supported environments, including the use of artificial intelligence to assist learning progression. Within this approach, student protagonism was developed through guided participation and pedagogical mediation. This study examines the implementation of a new pedagogical approach in a basic education school situated within an innovation-oriented environment, analyzing how this model was structured, translated into the local educational context, and remained aligned with international educational trends and research on active learning and student engagement.

2. Methodology

This study adopts an institutional case study design to examine the implementation of an active learning model developed within an innovation ecosystem. This methodological approach is suitable for investigating complex educational processes situated in real institutional contexts, particularly when the objective is to understand pedagogical organization, implementation dynamics, and emerging educational outcomes rather than to test controlled experimental interventions [7,8].
Data were derived from multiple institutional sources, including documentation of interdisciplinary projects, records of student participation in academic and scientific activities, and institutional pedagogical reports. Data triangulation based on documentary sources strengthened methodological rigor and enabled a comprehensive understanding of how active learning and other pedagogical strategies were implemented during the initial phase of the pedagogical model [9,10].
The temporal scope of the study spans from January 2025 to February 2026, covering the first year of operation of Colégio Donaduzzi and the initial implementation phase of its pedagogical model within the Biopark innovation ecosystem in Toledo, Paraná, Brazil.

3. Results and Discussion

The following sections present the results organized into four subtopics: teaching professionals, learning environments and pedagogical practices, integration with the innovation ecosystem, and student and institutional outcomes.

3.1 Teaching Professionals

Colégio Donaduzzi is grounded in the principle that the quality of educational innovation is directly related to the qualification, stability, and continuous development of its teaching professionals. For this reason, the institutional model incorporates structured processes for teacher selection, professional valorization, and pedagogical development as central elements for the implementation of relationally oriented pedagogical practices grounded in teacher–student interaction.
The recruitment process involves a comprehensive evaluation of academic background and professional trajectory, including prior teaching experience and engagement in research activities. Candidates are assessed through a structured selection process conducted by a panel of specialized educators and participate in a simulated classroom teaching session, enabling the evaluation of pedagogical competence, communication skills, and alignment with the institutional educational approach. All teachers are specialists in their respective fields, with 82% holding postgraduate qualifications corresponding to ISCED above 6. According to the International Standard Classification of Education (ISCED), developed by UNESCO, level 6 corresponds to bachelor's or equivalent degrees,

level 7 to master's or equivalent degrees, such as postgraduate programs of strong specialization, and level 8 to doctoral or equivalent research degrees [11].
To contextualize the institutional qualification profile, Tables 1 and 2 compare Colégio Donaduzzi with national and international benchmarks from the Brazilian School Census 2024 and TALIS 2024, covering overall qualification levels and doctoral-level training.

Table 1. Teacher qualification profile (basic education) in national and international comparison according to ISCED classification [11,12,14].

Context	ISCED < 6	ISCED 6	ISCED > 6
Colégio Donaduzzi	0.0%	17.9%	82.0%
School Census 2024 - Brazil	10.3%	42.7%	48.0%
TALIS 2024 - International	3.2%	38.1%	59.7%
TALIS 2024 -Top 1: Slovak Republic	0.6%	0.9%	98.5%
TALIS 2024 -Top 2: Poland	0.3%	2.3%	97.4%
TALIS 2024 -Top 3: Croatia	0.6%	4.5%	94.5%
TALIS 2024 -Top 4: Portugal	0.9%	5.0%	94.1%
TALIS 2024 -Top 5: Finland	3.7%	4.5%	91.8%

Table 2. Proportion of teachers at ISCED level 8 (doctoral level) in national and international comparison [11,13,14].

Context	ISCED 8
Colégio Donaduzzi	12.8%
School Census 2024 - Brazil	1.1%
TALIS 2024 - International	1.7%
TALIS 2024 -Top 1: Italy	5.2%
TALIS 2024 -Top 2: Cyprus	4.9%
TALIS 2024 -Top 3: Spain	4.8%
TALIS 2024 -Top 4: Romania	4.3%
TALIS 2024 -Top 5: Czechia	3.8%

Together, these data indicate that Colégio Donaduzzi presents a higher proportion of teachers with postgraduate and doctoral qualifications than national averages and approaches patterns observed in education systems characterized by strong academic preparation of teaching professionals.
Colégio Donaduzzi adopts employment conditions aimed at attracting and retaining highly qualified professionals. Teaching contracts are structured with full institutional dedication (100%), encompassing the teacher's weekly workload within the school. This model differs from the national Brazilian context, in which a substantial proportion of teachers work under part-time arrangements and approximately 41% need to divide their weekly workload across two or more schools. At the global level, around 20% of teachers work part-time across education systems. Among these, 17% work in only one school, indicating that a substantial proportion of part-time teachers are employed across more than one school, reflecting fragmented professional arrangements and representing a relevant share of teachers working across multiple institutions worldwide [11, 14, 15].
Within the full-time model adopted by Colégio Donaduzzi, half of this workload is allocated to classroom teaching, while the remaining time is dedicated to lesson planning, development of instructional materials, individualized mentoring of students, developing research projects, and continuous professional development, supported by sufficient administrative staff to allow teachers to focus primarily on pedagogical activities. This configuration also differs from the broader Brazilian educational reality, where Federal Law No. 11.738/2008 establishes a maximum distribution of 2/3 of teachers' working time for classroom instruction and 1/3 for extracurricular pedagogical activities, which may include administrative tasks [16]. In practice, however, schools frequently tend to allocate teachers as close as possible to the maximum permitted time in classroom teaching, a condition associated in the literature with reduced well-being and increased work-related stress among teachers, thereby constraining the time, cognitive availability and pedagogical flexibility required to effectively implement active and personalized teaching approaches [17].
At the institutional level, the school also provides dedicated facilities for teachers, including a staff lounge equipped with kitchen facilities, designed to support rest, interaction and well-being during the working day. International evidence indicates that teacher well-being is influenced by multiple factors beyond remuneration, including workload, working conditions, leadership support and opportunities for continuous professional learning; however, salary remains a significant element associated with professional satisfaction and retention in the teaching career [11].
Based on these considerations, teacher valorization is also expressed through remuneration practices above the local average. The entry-level salary is approximately 26% higher than the national salary floor for public basic education teachers in Brazil, while the average remuneration is about 50% higher than the mean salary observed in public basic education teaching positions [18,19], as well as through institutional investment in continuous professional learning pathways. The school provides structured support for the development of individualized professional growth plans and offers continuing education opportunities embedded within the working schedule. As part of these actions, teachers were offered postgraduate specialization programs, each exceeding 360 hours and provided free of charge, including training in learning practices and the development of neurodivergent students, as well as participation in the Star Lessons program, developed through a partnership between Biopark Educação and the

University of Helsinki and recognized as an international professional development initiative originating in Finland. This program was also part of an institutional strategy aimed at strengthening international collaboration. Within this international dimension, knowledge exchange dialogues were established with educational institutions in Finland, the United States, and Portugal. These activities were supported by in loco visits aimed at identifying collaboration opportunities and informing future international engagement of teachers.
Beyond postgraduate training, the institution also promoted professional engagement at the international level, both by hosting and sending educators, including the visit of a renowned educator from Portugal to Brazil to deliver lectures for all teaching professionals, as well as an immersion experience carried out in Finland, in schools internationally recognized for pedagogical excellence, in which 17 teachers from Colégio Donaduzzi participated, enabling them to observe educational practices in context and subsequently adapt these experiences to the Brazilian basic education reality.
Furthermore, other institutional practices contribute to teachers' professional support, including continuous dialogue with institutional leadership, which provides ongoing feedback and feedforward on professional development and offers guidance when challenges are identified.

3.2 Learning Environments and Pedagogical Practices

Learning environments are structured as thematic laboratories rather than conventional fixed classrooms, reflecting an infrastructure intentionally designed to stimulate students' curiosity, creativity, and engagement. Each discipline is associated with its own dedicated environment, for example, a Mathematics laboratory organized with challenges and educational games, and a science laboratory equipped with instruments and reagents to support experimentation aligned with the topics addressed in class. This configuration enables students to move beyond abstract content, engaging directly with concepts through practical experience and experimentation, so that learning is constructed not only through theory but through concrete interaction with the subject matter [20].
The integration of digital tools supports pedagogical organization and formative assessment practices. Each student was provided with an individual portable computer to support digital learning activities and access to intelligent educational platforms that facilitate the monitoring of academic progress and the generation of information to support feedback processes.
Classes are limited to a maximum of 24 students, a size considered pedagogically appropriate to allow closer monitoring of learning processes and effective classroom management by the teacher, also influencing the quality of perceived teacher–student interactions and, consequently, higher levels of student satisfaction [17]. Within each laboratory, learners are typically organized into 4 collaborative learning islands composed of 6 students, fostering teamwork, peer interaction, and collective problem solving. According to the pedagogical objectives of each lesson, the spatial configuration can be reorganized by the teacher, allowing the environment to adapt dynamically to different learning activities.
Each class lasts 50 minutes, followed by a 5 minutes pause for transition between laboratories according to students' schedules. This circulation contributes to maintaining students physically and cognitively active, while each change of environment functions as a new moment of immersion in the subject area.
In this model, space is not simply a physical setting but becomes an active component of the learning process, supporting active and personalized teaching practices [21]. In addition, the school provides dedicated spaces for rest, emotional regulation, and guided study, supporting students' well-being, cognitive recovery, and targeted academic assistance. Differently from the prevailing schedule observed in most Brazilian schools, at Colégio Donaduzzi classes began after 8:00 a.m., a timing consistent with evidence indicating that later school start times are associated with longer sleep duration, improved cognitive functioning, and better academic and mental health outcomes among adolescents [22].
Students participate in a diagnostic assessment when they enter the school, and the results are analyzed by a multidisciplinary pedagogical team. Based on this assessment, working groups are organized to guide classroom activities, aiming to promote complementarity among students and support the progressive development of socioemotional competencies, leadership, collaboration, and other dimensions relevant to learning and personal development.
Each student is also assigned a faculty mentor who provides individual guidance for approximately one hour per week. During the first weeks of the school year, students indicate three preferred teachers to act as mentors, and the school allocates mentorships according to availability to ensure that all students are supported. Mentoring sessions focus on students' academic and personal development and on the continuous refinement of their individualized development plan, referred to as the Life Plan. Whenever necessary, the multidisciplinary pedagogical team supports both students and mentors, contributing to monitoring progress and guiding decision-making throughout each student's developmental trajectory.

When specific learning needs are identified in particular subjects, mentors may recommend the organization of supplementary instructional groups to provide targeted academic support. Students' academic progress, activities, and individualized development plans are systematically recorded in a pedagogical learning log, supporting monitoring, feedback, and communication among teachers, mentors, and the pedagogical team.

Within classroom settings, pedagogical practices were organized around core dimensions aligned with relational pedagogical principles and active learning. Teaching strategies positioned students as active agents in the learning process through project-based activities, problem-oriented tasks, and collaborative knowledge construction. Classroom experiences were designed to support creativity, experimentation, and innovation as components of cognitive engagement. Socioemotional dimensions were also incorporated into the pedagogical organization, with emphasis on structured interactions, active listening, and respectful communication, contributing to students' emotional development and learning engagement. The pedagogical model further emphasized the development of transversal competencies, including communication, problem-solving, interpersonal collaboration, and leadership. These elements were integrated into classroom dynamics to support student participation, motivation, and sense of belonging, understood as relevant factors in the learning process.

Assessment practices were formative and participatory, focusing on performance and learning trajectories. Instruments included learning records, self- and peer assessment, and project-based evaluation, with trimester presentations supporting the monitoring of student development.

Students participated in comprehensive institutional evaluation processes conducted at the end of each trimester, providing structured feedback on learning environments, teaching practices, teacher performance, administrative procedures, transportation logistics, the quality of school meals, and the overall organizational functioning of the school, thereby contributing to a broad and systematic assessment of both pedagogical and operational dimensions of the educational experience.

The school approaches technology as a means to enhance human development and learning processes rather than as an end in itself. Digital resources are integrated transversally into the curriculum to support inquiry, collaboration, knowledge construction, and formative assessment, while maintaining the human dimension as central to educational practice. Within this perspective, technological integration is understood as a pedagogical instrument that supports students' autonomy, critical thinking, and responsible engagement with digital environments.

In alignment with this approach, the institution introduced a dedicated Artificial Intelligence (AI) course for upper secondary students, expanding structured opportunities for digital literacy and computational thinking within basic education. This initiative positions the school among early adopters of curricular AI education in the Brazilian context, reflecting its commitment to aligning educational practices with emerging technological and societal developments.

To begin within the Brazilian regulatory framework for bilingual education, Colégio Donaduzzi chose not to operate initially as a bilingual school. In Brazil, a bilingual school is defined as one that implements a single, integrated curriculum delivered in two languages, with a minimum proportion of instruction conducted in the additional language (30% in elementary education and 20% in upper secondary education) [23,24]. Instead, the institution opted to implement a bilingual program, characterized by extended exposure to the English language within the school schedule. Approximately 20% of instructional time was conducted in English, supported by daily language classes. This decision considered that, in its first year, the school offered classes for the final year of elementary education and all grades of upper secondary education, and that many learners might not yet have sufficient linguistic background to immediately engage in content-based instruction delivered through English, in which curricular subjects are taught in the additional language, potentially affecting their academic development. Research indicates that, particularly among learners with limited prior exposure to the additional language, the integration of disciplinary content and a second language may affect students' comprehension and engagement with subject matter. Evidence from studies on bilingual and content-based language education shows that, in the initial stages of implementation, learning gains are more consistently observed in language development than in disciplinary achievement, and outcomes in content learning tend to vary according to students' linguistic readiness and the conditions of implementation. These findings support recommendations to strengthen explicit language instruction and to adopt gradual or sequential models before expanding subject teaching in English [25,26]. The adopted approach therefore reflects contextual adaptation and alignment with recommendations from the literature on gradual implementation of bilingual education.

As a key component of its institutional strategy to strengthen student protagonism, engagement, and curriculum development, the school organized the daily timetable to ensure alignment with the curricular components required by the Brazilian National Curriculum Guidelines for Basic Education issued by the

Ministry of Education, while also providing opportunities for the personalization of education in the complementary period. Teaching and learning practices were structured according to active and experiential learning strategies, interdisciplinary project work, and personalized learning pathways as central elements of the educational model. The pedagogical organization was articulated through interdisciplinary projects, collaborative learning environments, inquiry-oriented activities, and the integration of digital resources into teaching and learning processes. These strategies were designed to promote student engagement and the articulation between academic knowledge and real-world problem solving. The model was influenced by principles of active learning, including project-based learning and phenomenon-based learning, as well as by the integration of digital technologies and artificial intelligence, while maintaining the human dimension as a central element of educational processes. Personalization of learning was established as a core component of this approach, supported by individualized mentoring and continuous guidance in the definition and development of students' learning pathways according to their interests, needs, and future aspirations.

Finally, as one of the school's main distinguishing features, in the complementary period students were able to fully personalize their developmental trajectories by selecting areas aligned with their individual interests and vocations from approximately 60 possibilities, encompassing science, arts/culture, sports, and technology. This stage of personalized education was implemented within a dedicated structure integrated with Colégio Donaduzzi, located in the Biopark innovation ecosystem and known as Academia Donaduzzi, an institution that is part of Biopark Educação. The Academia Donaduzzi provided additional specialized learning environments, including laboratories for food science, pharmacy, microbiology, arts and culture, and information technology, as well as a makerspace equipped with 3D printers and infrastructure for prototyping and woodworking, in addition to sports facilities and other resources. Within this context, students were able to design and pursue individualized learning pathways aligned with their interests and developmental needs. This approach enabled the exploration and consolidation of competencies connected to personal aspirations, while establishing links between school experiences, higher education trajectories, and potential entry into the labor market.

3.3 Integration with the Innovation Ecosystem Biopark

The integration of Colégio Donaduzzi within the Biopark innovation ecosystem enabled continuous interaction with companies, research initiatives, and educational institutions, providing students with access to infrastructure, technological resources, and innovation-oriented environments. Educational activities were supported by proximity to laboratories, entrepreneurial initiatives, and institutional networks that characterize the ecosystem.

This integration translated into concrete educational opportunities for students. Within this context, students also had access to an entrepreneurial development pathway through a child-focused incubation program linked to the innovation ecosystem. For younger participants, the initiative was adapted into a pre-incubation format appropriate to their age and stage of development. In this program, students were able to develop their own business ideas and projects, developing products or services as well as entrepreneurial proposals, while receiving technical guidance and support from professionals associated with the technology park. At the time of this study, 17 initiatives participated in this program, with approximately 20 additional initiatives projected for 2026.

Scientific initiation activities also formed part of the integration between the school and the innovation ecosystem, involving students in research-oriented projects connected to real-world problems and innovation contexts. The school is currently selecting 30 projects involving up to 50 students, in which each participant will receive a monthly research fellowship of R$ 300 to support their dedication to research activities. These projects are generally developed in dialogue with demands and areas of interest identified within the Biopark ecosystem, strengthening the relationship between school-based research, technological development, and local innovation dynamics.

The relationship between the school and the ecosystem was not unidirectional. The presence of the school also contributed to the dynamics of the ecosystem by expanding the circulation of people and strengthening connections between educational and innovation environments. The student population comes from a regional area that includes 21 municipalities within an approximate radius of up to 290 km, with the host city accounting for about 67% of total enrollment. Families connected to the Biopark ecosystem, including those working in companies and research institutions, became actively involved in school activities. At the same time, the school also attracted new social groups who would not normally access the Biopark environment on a daily basis, representing more than 90% of the student population.

In addition, the school functions as an early educational stage within a broader educational trajectory associated with the innovation ecosystem, which includes higher education institutions located within

the same environment, such as Faculdade Donaduzzi and public universities. In this sense, students represent potential future participants in the innovation ecosystem, contributing to the continuity of educational and professional pathways aligned with research, entrepreneurship, and technological development.

3.4 Student and Institutional Outcomes

Colégio Donaduzzi began its activities with an initial enrollment of 303 students and, within a short period, expanded to 554 students. Participation in personalized learning pathways beyond regular class hours was observed among 422 students, indicating strong engagement with the personalized learning model beyond the compulsory instructional components required by Brazilian basic education regulations. Institutional records also indicate that 160 students have formal diagnoses associated with high abilities. This profile reinforces the relevance of differentiated pedagogical strategies, mentoring, and project-based learning structures and represents a distinctive feature of the school, which is particularly responsive to the needs of high-ability learners.

As a private non-profit educational institution, Colégio Donaduzzi incorporates financial support as an important component of its access model. The majority of students receive some form of scholarship support, determined by family socioeconomic conditions, parents' professional links with the Biopark ecosystem, partnerships with public programs, and internal academic selection processes. Overall, 66% of students receive scholarships, among whom 47% benefit from full scholarships, while an additional 19% receive partial support covering up to half of the tuition fees.

Project-based learning was implemented as a transversal pedagogical axis, with all students participating in interdisciplinary initiatives throughout the academic year. Projects were aligned with real-world challenges and, in many cases, connected to sustainability, technological innovation, and social inclusion. Several initiatives gained visibility in educational and media contexts, including the development of a nutritional supplement for cattle aimed at reducing methane emissions, biodegradable dressings with natural active compounds for acne treatment, and an intelligent wheelchair capable of interpreting facial movements to control mobility [27,28].

Student engagement in scientific fairs and academic competitions resulted in multiple recognitions across areas including sustainability, health, robotics, entrepreneurship, technological development, languages, engineering, and astronomy, totaling 33 medals and 63 honorable mentions in national Olympiads, as well as 12 medals in regional contests. As an illustrative example of performance above the national average, data from the Brazilian Astronomy Olympiad (OBA) indicate that the school achieved an award rate of 8.2%, compared to the national average of 5.6%, representing a performance more than 45% higher than the national benchmark. A similar pattern was observed in the Brazilian Public Schools Mathematics Olympiad (OBMEP), in which approximately 10% of participating students advanced to the second phase, compared to a national average of 5%, corresponding to twice the national rate [29].

Diagnostic evaluations conducted at the time of student entry revealed heterogeneous learning levels across curricular components, guiding the implementation of personalized learning strategies and academic support pathways. Subsequent internal evaluations indicated progressive improvement in average performance across disciplines over the academic terms, increasing from an average of 6.5 to 8.7 (maximum score of 10) in the first trimester of evaluations, suggesting stabilization of learning processes and consolidation of foundational competencies.

Survey data collected from students and families indicated high levels of satisfaction with pedagogical methodologies, learning environments, and institutional organization. Students rated teaching methodology at 8.8 and overall institutional performance at 8.6 (maximum score of 10), while parents or guardians reported ratings of 9.3 for methodology and 9.5 for overall institutional evaluation, reinforcing the perceived relevance of the educational model and its impact on student engagement.

At the ecosystem level, the integration between the school and the Biopark innovation environment produced additional impacts. As described in the previous subtopic, student participation in scientific initiation projects, entrepreneurial pathways, and applied research activities reinforced connections between basic education, technological development, and innovation practices. Furthermore, among students who completed the final year of upper secondary education, 100% were admitted to higher education entrance examinations, and 70% secured admission to higher education institutions within the Biopark ecosystem, enabling continuity of their educational trajectories within the same innovation environment.

4. Conclusion

The implementation of an educational model grounded in active learning, personalization, and integration with an innovation ecosystem was associated with high levels of student engagement, participation in interdisciplinary projects, and recognition in academic and scientific environments during the initial period analyzed.
Aligned with international evidence, the experience suggests that relational and inquiry-driven environments can foster autonomy, engagement, and academic resilience, while strengthening connections between schooling, research, and real-world problem solving.
Within the Brazilian educational context, Colégio Donaduzzi emerges as an institutional model structured to remain connected to global research agendas and educational innovation, translating internationally discussed pedagogical approaches into a locally grounded implementation.

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What Would Paulo Freire Think of Generative AI? Critical Pedagogy, Cognitive Offloading, and the Struggle for Humanisation

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Abstract

This paper examines generative artificial intelligence (GenAI) through the lens of Paulo Freire's critical pedagogy, exploring how the Brazilian educator and philosopher might assess contemporary AI technologies in education. Methodologically, it adopts a theoretical-interpretive approach, synthesising recent scholarship (2023–2026) on GenAI in education through a systematic application of Freire's foundational concepts, namely the banking model, problem-posing pedagogy, conscientisation, dialogue, humanisation, and praxis, as an analytical framework rather than reporting original empirical data. Whilst existing scholarship has applied individual Freirean concepts to AI critique, this paper makes a distinct contribution by offering a comprehensive and coherent Freirean reading across all of Freire's core pedagogical principles, and by moving beyond critique to propose a praxis-oriented framework of seven actionable strategies for AI integration. The analysis occupies a deliberate middle ground between techno-optimism and techno-pessimism, arguing that Freire would view generative AI as neither inherently emancipatory nor oppressive, but as a contested terrain requiring deliberate pedagogical choices that centre humanisation, equity, and social justice. The paper identifies persistent risks, including technocratic neutrality, algorithmic bias, and the displacement of authentic dialogue, whilst also recognising AI's emancipatory potential when implemented with critical pedagogical intentionality. Ultimately, it contends that Freire would call for a praxis-oriented approach to AI in education, one that transforms technology from an instrument of domination into a tool for critical consciousness and collective liberation.

Keywords: *Paulo Freire, generative AI, critical pedagogy, conscientisação, banking model, problem-posing education, AI literacy, cognitive offloading, skills atrophy, deskilling*

Introducton

> *I consider the fundamental theme of our epoch to be that of domination—which implies its opposite, the theme of liberation, as the objective to be achieved… In order to achieve humanisation, which presupposes the elimination of dehumanising oppression, it is absolutely necessary to surmount the limit-situations in which people are reduced to things [1].*

The rapid emergence of generative artificial intelligence (henceforth, GenAI), particularly large language models (LLMs) such as ChatGPT, Claude, and Gemini, has profoundly disrupted educational landscapes worldwide [2, 3]. These systems can generate essays, answer complex questions, create lesson plans, and engage in seemingly intelligent dialogue, prompting urgent questions about their role in teaching and learning [4, 5]. A survey of 337 higher education leaders in the USA conducted in late 2024 found that 71% of college students use AI tools for coursework [2]. As educators grapple with whether to embrace, resist, or critically integrate these technologies, Paulo Freire's critical pedagogy offers a powerful analytical framework [6, 7].

Paulo Freire (1921–1997) critiqued the “banking model” of education, in which teachers deposit knowledge into passive student receptacles [6, 8]. He advocated for “problem-posing” education rooted in dialogue, critical reflection, and transformative action, positioning education as inherently political and aimed at humanisation and conscientisation (conscientização): critical awareness of social contradictions and the capacity to act against oppressive elements of reality [9, 10]. Recent scholarship has applied Freirean concepts to GenAI, revealing both emancipatory possibilities and significant risks [11, 12, 13]. This paper synthesises this work and extends it by foregrounding the concern of cognitive offloading and skills atrophy, a risk that AI-enabled externalisation of cognitive tasks may erode the very competences education is designed to cultivate.

This paper adopts a theoretical-interpretive methodology. It does not report original empirical data; instead, it synthesises recent scholarship (2023–2026) on generative AI in education through the analytical lens of Freirean critical pedagogy. Sources were selected purposively to represent the emerging critical literature on GenAI across diverse educational contexts. The aim is conceptual. It attempts to build a Freirean reading of AI's pedagogical implications rather than to produce a systematic review or meta-analysis.

Drawing on Freire's pedagogical theory as an analytical framework, this paper seeks to occupy a middle ground, one that neither uncritically embraces nor wholesale rejects AI's role in educational practice. Whilst existing scholarship has applied individual Freirean concepts, particularly the banking model and conscientisation, to AI critique, this paper makes a distinct contribution by offering a systematic and comprehensive Freirean reading across all of Freire's core pedagogical principles. It further moves beyond critique to propose a coherent, praxis-oriented framework for AI integration, bridging theoretical analysis and practical strategy in ways that prior work has not fully developed. In doing so, it aligns with a growing scholarly effort to engage with AI in education in a measured, and critically informed manner.

The paper is structured as follows. Section 1 outlines the core concepts of Freire's critical pedagogy that are most relevant to the analysis of GenAI. Section 2 examines the risks that GenAI poses when viewed through a Freirean lens, with particular attention to the reproduction of the banking model, the masking of power relations, algorithmic bias, cognitive offloading and skills atrophy, the political dimension of AI-induced deskilling, and the accelerated displacement brought about by the agentic turn in AI development. Section 3 explores the emancipatory possibilities of GenAI when deployed within genuinely critical pedagogical frameworks. Section 4 synthesises these findings into a set of practical commitments for educators seeking to align AI integration with Freirean principles. The conclusion reflects on what Freire's legacy demands of educators in the age of AI.

1. Freire’s Critical Pedagogy: Core Concepts and Principles

1.1 The Banking Model versus Problem-Posing Education

Freire’s critique of the “banking model” of education remains the cornerstone of his pedagogical vision. In this model, education becomes “an act of depositing, in which the students are the depositories and the teacher is the depositor” [1]. Students are treated as empty vessels to be filled with predetermined knowledge, rendering them passive objects rather than active subjects in their own learning. This approach serves the interests of oppression by discouraging critical thinking and maintaining existing power structures. Knowledge, in the banking model, is a finished product to be consumed rather than a living process to be co-created, and the student’s role is one of reception, filing, and storage rather than critical engagement and transformation. The model is not merely an inefficient pedagogy but a political instrument: by training students to receive and accept rather than question and transform, it reproduces the conditions of their own subordination.

In contrast, Freire advocated for “problem-posing” education, which positions teachers and students as co-investigators of reality. This dialogic approach treats knowledge not as a static commodity to be transferred but as something co-created through critical inquiry grounded in learners’ lived experiences. The teacher-student relationship is reconceived as one of mutual learning: teachers learn from students as students learn from teachers, in a horizontal exchange that respects the knowledge all participants bring to the educational encounter. Recent analyses emphasise that Freire’s distinction between these models remains highly relevant to AI integration, as generative systems can easily default to banking-style knowledge delivery if not deliberately designed and framed otherwise [4].

1.2 Conscientisação and Critical Consciousness

Central to Freire’s pedagogy is the concept of conscientisação—the process of developing critical consciousness about social contradictions and the capacity to transform oppressive realities. This process moves beyond mere awareness to encompass “learning to perceive social, political, and economic contradictions, and to take action against the oppressive elements of reality” [1]. Freire understood consciousness-raising not as an individual psychological process but as a collective political one, tied to broader struggles for social justice. Generative AI can either facilitate critical consciousness by revealing algorithmic bias and social structures, or it can naturalise these biases and hinder conscientisação if used uncritically [7]. The question becomes whether AI tools are deployed to encourage questioning and critique or to deliver seemingly authoritative answers that discourage deeper inquiry.

1.3 Dialogue and Humanisation

For Freire, authentic education requires dialogue—a horizontal relationship between teachers and students characterised by mutual respect, trust, and shared inquiry. Dialogue is not mere conversation but a transformative encounter that recognises the full humanity of all participants, standing in stark contrast to the vertical, authoritarian structures of banking education. Humanisation—the process of becoming more fully human—represents the ultimate goal of Freirean pedagogy, orienting educational technology towards equity, dignity, and access rather than mere efficiency or profit [10]. This humanising imperative must function as an ethical constraint on any educational use of AI.

1.4 Praxis: The Unity of Reflection and Action

Freire insisted on the unity of reflection and action, which he termed 'praxis'. Authentic praxis requires both critical reflection on reality and transformative action to change it. Neither reflection without action (verbalism) nor action without reflection (activism) constitutes genuine praxis. This dialectical relationship between thought and action drives both individual conscientisação and collective liberation. Recent scholarship suggests that generative AI can be integrated into cycles of praxis when used to surface problems, support critique, and inform collective action [7]. However, automated systems risk substituting reflection with optimisation metrics unless pedagogically mediated to maintain the reflective dimension essential to genuine praxis [11].

2. Generative AI as Banking Model 2.0: Risks and Reproductions

2.1 The Delivery of Packaged Knowledge

Generative AI systems excel at producing seemingly authoritative, polished responses to student queries, potentially transforming education into an even more efficient banking operation. Rather than teachers depositing knowledge, AI systems deliver instant answers that discourage students from engaging in the messy, uncertain process of inquiry and knowledge construction. Without deliberate pedagogical redesign, AI reinforces teacher-as-depositor roles by providing ready-made answers and narrowing inquiry [4, p.89]. This risk is particularly acute because AI-generated content often appears comprehensive and confident even when inaccurate or incomplete, inviting uncritical consumption rather than critical engagement. The ease of generating essays, summaries, and solutions fosters an instrumental, consumption-style relationship to learning that prioritises efficiency over understanding, credentialisation over conscientisação.

2.2 Technocratic Neutrality and the Masking of Power Relations

Freire emphasised that education is never neutral; it either serves to integrate students into the existing system or enables them to question and transform it. Generative AI is frequently promoted through technocratic framings that present it as a neutral efficiency tool, masking the power relations and ideological commitments embedded in these systems [12]. This apparent neutrality conceals multiple forms of power. AI systems embody the values and biases of their creators and training data, often reflecting dominant cultural perspectives whilst marginalising others. Corporate ownership of major AI platforms concentrates power in the hands of technology companies (primary, American). Therefore, the emphasis on efficiency and scalability serves neoliberal educational reforms that prioritise measurable outcomes over humanisation and critical consciousness. Freire would critique this technocratic framing as a contemporary form of "false generosity". This, for Freire and later critical pedagogists, is a gesture that appears beneficial whilst ultimately maintaining oppressive structures.

2.3 Algorithmic Bias and Automated Inequality

Generative AI systems trained on historical data inevitably reproduce the biases present in that data, including racial, gender, cultural, and linguistic biases. These systems can generate content that perpetuates stereotypes, marginalises non-dominant perspectives, and reinforces existing inequalities [7, p.7]. Beyond content bias, AI creates new structural inequalities: students and schools with greater access to advanced AI tools gain advantages over those without, potentially widening existing educational divides. The digital divide becomes an AI divide, with implications for who can participate fully in an increasingly AI-mediated world. Freire would recognise this as a contemporary manifestation

of oppression: the use of technology to maintain hierarchies and exclude marginalised communities from full participation in knowledge creation and social transformation [9].

2.4 Cognitive Offloading and the Atrophy of Competence

Cognitive offloading, that is,the practice of externalising cognitive tasks to tools and technologies—is not inherently problematic. Writing itself is a form of cognitive offloading; so is the use of calculators, GPS navigation, and reference databases. Clark and Chalmers [16] argue that cognitive processes 'can be partly constituted by, and partly located in, the environment,' and that this extension can enhance rather than diminish human cognitive capacity. Their famous example of Otto's notebook as a genuine component of his memory system illustrates how cognitive extension can be enabling rather than diminishing.

However, the current scale and scope of AI-enabled cognitive offloading raises qualitatively distinct concerns. Sparrow et al. [13] documented what they termed 'the Google effect': the finding that 'when people expect to have future access to information, they have lower rates of recall of the information itself.' Risko and Gilbert [16] have noted that the consequences of cognitive offloading depend critically on 'whether or not the offloaded processing contributes to learning.' More recently, Gerlich [19] has documented correlations between habitual AI tool use and diminished critical thinking capacities, arguing that when AI systems perform the evaluative and generative work that produces competence, repeated use may erode rather than scaffold that competence.

In educational contexts, this concern takes on particular urgency. Students who use LLMs to generate essays are not merely submitting work they did not produce; they are potentially forgoing the cognitive work through which writing competence, argumentation skills, and disciplinary knowledge are developed. The short-term efficiency gain may come at the long-term cost of the very capacities that education is meant to cultivate. From a Freirean perspective, this is especially troubling because the atrophy of critical cognitive competences directly undermines the possibility of conscientisação: one cannot develop critical consciousness whilst outsourcing one's critical thinking to an algorithm.

2.5 Freire and the Political Dimension of Deskilling

What Freire adds to this cognitive analysis is the insistence that deskilling is not merely a technical phenomenon but a political one. For Freire, the dehumanisation of workers, that is, their reduction to passive instruments of a productive process they neither understand nor control, is not an unfortunate side effect of technological change but an expression of the fundamental logic of oppression [1]. AI-induced deskilling, viewed through this lens, is an expression of the power relations governing who controls the means of cognitive production, who benefits from the automation of skilled labour, and who bears the costs.

This political dimension is amplified by the economic logic that drives AI development. As Zuboff [20] argues, surveillance capitalism 'claims human experience as free raw material for translation into behavioural data'—a logic that AI-enabled deskilling intensifies. When legal AI systems automate the analytical work of junior lawyers whilst leaving the profits of law firms intact, when algorithmic management systems reduce skilled workers to responsive appendages of an optimisation engine, these are not neutral technological developments. They are expressions of a logic that extracts value from human cognitive labour whilst systematically undermining the conditions under which that labour can be meaningfully exercised. Freire would insist that educators name this logic rather than accommodate it.

2.6 The Agentic Turn and Accelerated Displacement

The recent development of agentic AI systems—AI capable of planning and executing multi-step tasks autonomously, browsing the web, writing and running code, managing files, and interacting with external services—marks a qualitative escalation in the scope of potential deskilling and displacement. Where earlier AI tools augmented specific tasks within a human-directed workflow, agentic systems begin to approximate the autonomous performance of entire job roles [13].

This development amplifies the Freirean concern in two ways. First, it accelerates the displacement of workers from roles that previously required substantial expertise, concentrating the benefits of this displacement among those who own and control the agentic systems. Second, it deepens the opacity of the productive process: agentic AI produces outputs whose reasoning is often opaque even to the system's creators. This opacity is fundamentally antithetical to the Freirean ideal of praxis. Freire insists

that reflection and action must be consciously integrated—that genuine praxis requires workers who understand what they are doing and why [1]. A labour process mediated by inscrutable algorithms forecloses this understanding by design, producing what might be called 'automated verbalism': outputs without genuine reflection.

2.7 The Displacement of Dialogue and Agency

Perhaps most troubling from a Freirean perspective is the potential for generative AI to displace authentic dialogue—the horizontal, humanising encounter between teachers and students that Freire considered essential to transformative education. As AI systems become more sophisticated in simulating conversation, there is a growing risk that human-AI interaction will substitute for human-human dialogue, fundamentally altering the relational dynamics through which conscientisação develops [17]. When students turn habitually to AI for answers, feedback, and guidance, the locus of educational interaction shifts from the classroom community to individual interactions with algorithmic systems, undermining the collective dimension of Freirean learning.

Moreover, agentic AI systems that can independently perform cognitive tasks risk reconfiguring student agency itself. If AI drafts essays, solves problems, and conducts research on students' behalf, students may be positioned as managers or consumers of AI outputs rather than as active knowledge creators. This reconfiguration contradicts Freire's insistence that students must be subjects, not objects, in their own education. It mirrors precisely the dehumanising dynamic he identified in the banking model.

2.8 Misinformation and the Post-Truth Challenge

GenAI systems remain prone to "hallucinations": the generation of plausible-sounding but factually incorrect information. This tendency contributes to what scholars describe as post-truth problems in knowledge formation, where the distinction between accurate and inaccurate information becomes increasingly difficult to maintain [14]. For Freire, pedagogy depended on the critical reading of reality:

> *"Reading the world always precedes reading the word, and reading the word implies continually reading the world." [15]*

The proliferation of AI-generated misinformation therefore represents a serious obstacle to conscientisação. When students cannot reliably distinguish between accurate and fabricated information, their capacity to develop critical consciousness about actual social conditions is fundamentally compromised. The problem is compounded by AI's authoritative presentation style, which can lend false credibility to incorrect information and discourage the critical scepticism that Freire considered essential to education.

3. Generative AI as Tool for Liberation: Emancipatory Possibilities

Whilst the risks are substantial, a rigorous Freirean analysis must also recognise generative AI's potential to support liberatory education when implemented with critical pedagogical intentionality. Freire was not a technological determinist; he understood that tools could serve either oppression or liberation depending on how they were used and for what purposes. Several emerging approaches demonstrate how AI might be aligned with Freirean principles, particularly when the risks of skills atrophy and deskilling are explicitly addressed.

3.1 Supporting Problem-Posing Inquiry and Critical AI Literacy

Generative AI can facilitate problem-posing education when used as a tool for iterative inquiry rather than as an answer engine. Instead of accepting AI outputs as final knowledge, students can use these systems to generate hypotheses, explore alternative perspectives, and frame problems for further investigation. As Alm and Watanabe demonstrate in language education, AI can co-create localised communicative scenarios that students then critique and refine, positioning learners as active knowledge constructors rather than passive recipients [4]. Recent studies suggest practical strategies: designing assignments that require critique of AI outputs, using AI to scaffold inquiry rather than deliver final answers, and creating tasks where students must verify, contextualise, and improve AI-generated content [4].

In the context of skills atrophy, this approach is particularly significant. By requiring students to interrogate, verify, and improve AI outputs rather than simply accept them, educators can ensure that AI use contributes to rather than displaces the development of competence. The key pedagogical move

is to position AI as a provisional text to be critically read rather than an authoritative source to be consumed—a move that aligns directly with Freire's vision of education as the critical reading of both the word and the world. Critical AI literacy must therefore encompass not only technical understanding and ethical reasoning but also students' metacognitive awareness of when AI use is enhancing versus replacing their own cognitive development.

3.2 Revealing Algorithmic Bias and Fostering Conscientisação

Paradoxically, the very biases embedded in AI systems can become pedagogical resources for developing critical consciousness. When students systematically interrogate AI outputs for bias, stereotypes, and cultural assumptions, they engage in precisely the kind of critical analysis that Freire advocated. As Warr argues, classroom activities that interrogate AI-generated content for bias and social assumptions can build awareness of how power operates through technology and language [7]. This approach treats AI not as a neutral tool but as a text to be critically read because it is a manifestation of social structures and power relations that can be analysed and challenged.

This critical engagement can extend beyond analysis to transformative action. Students might design projects to audit AI systems for disparate impacts and develop collective proposals to mitigate harms, linking critical analysis to social transformation in a genuine cycle of Freirean praxis [7]. Such activities connect the critique of AI to broader struggles for equity and justice, maintaining the political orientation that Freire considered essential to genuine education.

3.3 Extending Dialogue Whilst Centring Human Relationships

Whilst AI cannot replace authentic human dialogue, it may extend dialogic possibilities when carefully integrated. Generative AI can serve as a provisional conversation partner that helps students develop and refine their thinking before engaging in classroom dialogue, functioning as a sparring partner for reflective questioning whilst teacher-facilitated dialogue remains central [4]. This use of AI is analogous to the role of a journal or a drafting process in preparing for genuine dialogue: it supports the individual work of thinking without substituting for the irreducibly social process of meaning-making through encounter with other human beings.

The key distinction is between AI as a tool that supports students' capacity for dialogue and AI as a replacement for dialogic relationships. AI might support dialogue by helping to surface tacit knowledge, generate diverse perspectives for consideration, or provide linguistic scaffolding for students developing academic discourse. In language education, for example, AI can help students practise communicative scenarios and build confidence for human interaction [4]. In this framing, AI functions as a kind of rehearsal space for dialogue rather than a substitute for it. Crucially, the primacy of human relationships in transformative education must remain non-negotiable: Freire's vision of education as humanising encounter cannot be realised through interaction with an algorithm, however sophisticated, because it requires the genuine recognition of another human subject whose freedom and dignity one is called to honour.

3.4 Enabling Praxis Through Iterative Design and Reflection

Generative AI can be integrated into cycles of praxis when used in iterative design processes. Students might use AI to prototype interventions, analyse outcomes, and revise their approaches in ongoing cycles of action and reflection. This application is evident in professional education contexts, where AI-generated case variations support reflective practice and ethical reasoning [21]. For example, students addressing a community problem might use AI to generate potential solutions, critically evaluate these proposals, test implementations, reflect on results, and refine their approach. The AI serves as a tool within a larger praxis cycle rather than as an endpoint of inquiry. Critically, this use of AI for praxis must remain grounded in authentic problems and oriented towards real-world transformation, ensuring that reflection and action address actual conditions and work towards genuine liberation rather than academic simulation.

4. Towards a Freirean Praxis of AI in Education

Based on this analysis, Freire would likely call for a praxis-oriented approach that neither uncritically embraces nor reflexively rejects AI but critically engages these technologies in service of humanisation and liberation [10]. This approach involves several inter-related commitments that together constitute a

Freirean framework for educational AI. Crucially, this framework does not treat AI integration as a technical problem to be solved by better instructional design alone, but as a political problem that requires ongoing critical vigilance about the social relations and power structures that AI technologies embody and reproduce.

Thus, any integration of AI in education must be evaluated against the criterion of humanisation, asking continuously whether AI applications strengthen authentic dialogue, support students as subjects in their own education, and foster critical consciousness rather than passive acceptance [10]. This means prioritising human relationships, learner agency, and social justice over efficiency, standardisation, or profit. Institutional decisions about AI adoption must be governed by this humanising criterion rather than by vendor marketing, administrative convenience, or competitive pressure from peer institutions.

Freire's vision of "reading the word and the world" as critical consciousness demands what scholars call "critical AI literacy": encompassing technical understanding of how AI systems work, critical analysis of bias and accuracy, ethical reasoning about social implications, and agentic engagement with AI outputs [4, 7]. Crucially, given the risks of skills atrophy, this literacy must also include metacognitive awareness of cognitive offloading: students should learn not just how to use AI tools but how to monitor whether that use is building or eroding their own competences. Educators must design learning environments in which AI use is structured to ensure that the offloaded processing contributes to learning, in the terms established by Risko and Gilbert [16], rather than short-circuiting it.

Given AI's potential to displace authentic human dialogue and reconfigure agency in dehumanising directions, Freirean approaches must deliberately protect dialogic relationships. Classroom communities must remain spaces of horizontal, humanising encounter, with teacher-facilitated discussion as the primary site of meaning-making and conscientisação. AI supplements rather than supplants the irreducibly relational character of critical pedagogy.

AI integration should support problem-posing pedagogy rather than defaulting to banking-model knowledge delivery. This requires framing AI as a tool for generating questions and hypotheses rather than providing final answers, and positioning AI outputs as provisional texts to be read critically. Instructional design must ensure that working with AI actively engages rather than bypasses the cognitive processes that develop competence, guarding against the deskilling dynamic that Gerlich [19] and Sparrow et al. [17] have empirically documented.

Moveover, given AI's tendency to reproduce existing biases and inequalities, Freirean approaches must actively identify and counteract these tendencies—auditing AI-generated content for bias, ensuring equitable access, involving diverse communities in implementation decisions, and monitoring AI's differential impacts on marginalised students. The goal is not merely to mitigate harm but to actively advance educational equity, consistent with Freire's commitment to the preferential option for the oppressed.

Finally, Freire's insistence on democratic and participatory education requires transparency about how AI systems work and genuine community participation in decisions about AI adoption and use. This challenges the technocratic model of AI implementation, resisting proprietary black-box systems and corporate dominance and insisting on democratic control of educational AI [2, 8]. The decisions about which AI tools are adopted, how they are used, and whose interests they serve must not be delegated to technology companies but made through processes of democratic deliberation that include educators, students, families, and communities.

Conclusion: AI as Contested Terrain

What would Paulo Freire think of generative AI? This analysis suggests he would view it as contested terrain: a site of struggle where competing visions of education, human development, and social justice collide. The question is not whether to use AI in education, but how, for what purposes, and in whose interests.

Freire would recognise that GenAI can easily reproduce and intensify the banking model of education, delivering packaged knowledge to passive students whilst masking power relations through claims of neutrality and efficiency. He would expose how corporate control, algorithmic bias, and the displacement of dialogue threaten to deepen educational oppression. The risks of cognitive offloading and skills atrophy add a further Freirean dimension that goes beyond earlier analyses: AI-enabled deskilling is not a neutral technical phenomenon but an expression of the power relations governing cognitive production and reproduction. The Google effect, extended mind research, and emerging evidence on AI's impacts on critical thinking together suggest that without deliberate pedagogical counter-measures, widespread AI use in education risks producing what Freire would recognise as a new and particularly insidious form of the banking model—one in which students are not only positioned as passive recipients of deposited

knowledge but are systematically stripped of the cognitive capacities that would enable them to resist that position.
The agentic turn amplifies these risks further, displacing skilled cognitive work whilst foreclosing the reflective understanding essential to praxis. When AI systems execute multi-step reasoning processes autonomously and opaquely, the conditions for genuine conscientisação—the capacity to perceive, reflect upon, and act against oppressive structures—are eroded at their root.
At the same time, Freire's pedagogy was never about rejecting tools but about transforming their use in service of liberation. AI can support problem-posing inquiry, reveal algorithmic bias as a site of conscientisação, extend dialogic possibilities, and enable praxis—provided that its integration is designed to preserve and develop learner agency and competence rather than displace them. The emancipatory possibilities of AI are real, but they require what Freire would call intentional praxis: ongoing critical engagement that refuses to accept technology on its own terms and insists on subjecting it to the criterion of humanisation.
Freire would call for an approach to AI in education that centres humanisation and social justice, develops critical AI literacy inclusive of metacognitive awareness of deskilling risks, preserves authentic dialogic relationships, designs for problem-posing rather than banking-model delivery, actively addresses bias and pursues equity, integrates AI into cycles of genuine reflection and action, and maintains democratic control over technological decision-making. These are not optional refinements to AI integration but its necessary preconditions if that integration is to serve rather than subvert the purposes of genuinely humanising education.
As educators navigate the AI epoch, Freire's pedagogy offers this essential guidance: education is never neutral, technology serves human purposes, liberation requires critical consciousness and collective action, and authentic transformation emerges from dialogue, praxis, and the ongoing struggle for humanisation. In the age of GenAI, these principles remain as urgent and indispensable as ever. The emergence of generative AI presents educators with a choice that Freire would find deeply familiar: will we use this technology to integrate students more efficiently into existing oppressive structures, or will we transform it into a tool for critical consciousness and collective liberation? The answer depends not on the technology itself but on the pedagogical, political, and ethical commitments that guide its implementation. Freire would remind us that this choice is not made once and for all but must be enacted continuously through praxis—the ongoing, vigilant unity of critical reflection and transformative action.

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Linking Statistics Education to Professional Practice: An Experiential Learning Approach in Economics and Business Degrees

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Abstract

The teaching of Statistics in Economics and Business degrees still faces the challenge of linking theoretical content with real-world applications, even as data availability and demand for analytical skills grow. Many students perceive Statistics as abstract and disconnected from professional practice, which reduces motivation, understanding, and the ability to apply methods to real problems.
To address this gap, the University of Oviedo implemented an innovative activity within the institutional initiative Professionals in the Classroom. In the course Introduction to Economic Statistics, students attended a session led by a senior statistician from the Asturian Society of Economic and Industrial Studies (SADEI).
The session highlighted the role of official statistics in economic and social analysis and included practical workshops using real data for business and public-sector decision-making. The design follows research on higher education innovation, which stresses active and contextualized learning and shows that real-world contexts improve attitudes toward Statistics.
Previous studies also indicate that collaboration with professionals enhances experiential learning, motivation, and students' perception of the practical usefulness of statistical methods when such activities are aligned with course objectives. A student satisfaction survey reported very positive evaluations and high overall satisfaction, suggesting that professional engagement initiatives effectively strengthen motivation and meaningful learning in Statistics education.

Keywords: *Applied statistics, Higher education innovation, industry-academia collaboration.*

Introduction

Statistics plays a central role in the training of economists and business graduates: it provides the analytical tools to interpret economic reality, make decisions and communicate empirical evidence based on data. However, despite the growing importance of data and the demand for analytical skills in the labour market, the teaching of this subject continues to face the problem that students tend to perceive it as extremely theoretical and abstract knowledge, completely disconnected from professional practice, which negatively affects their motivation, conceptual understanding and, ultimately, their ability to transfer statistical methods to real-life situations (Garfield et al., 2008).
This gap between theory and practice is not, of course, exclusive to statistics—it affects many quantitative subjects in the social sciences—but it is particularly pronounced in this field. The formal nature of its content, the density of the mathematical language used, and the frequent absence of applications to specific economic problems contribute to generating negative attitudes that, far from disappearing with the advancement of studies, tend to become entrenched (Gal and Ginsburg, 1994; Onwuegbuzie and Wilson, 2003).
The literature on innovation in higher education has identified various ways to address this gap. Among them, the experiential learning approach (Kolb, 1984) and the incorporation of external professionals into the classroom have received increasing attention for their ability to promote learning and give practical meaning to curricular content (Coleman, 2013; Ormrod, 2004). Existing evidence suggests that the participation of experts from the world of work not only increases student motivation but also strengthens their perception of the usefulness of what they have learned and facilitates the construction of more lasting and transferable knowledge (Kirby and Turner, 2024).

It is in this context that the experience described and analysed in this paper is framed. For several years, the University of Oviedo has been developing an institutional initiative called Professionals in the Classroom, aimed at integrating the perspective of external experts into the ordinary development of undergraduate degrees. During the 2024-2025 academic year, this initiative took shape in the field of statistics through the collaboration of a professional statistician from the Asturian Society of Economic and Industrial Studies (SADEI) in the subject Introduction to Economic Statistics. The activity combined an introductory lecture on official statistics with two practical workshops on the use of real data in decision-making and was very well received by the students according to the results of the satisfaction survey conducted for this purpose.
This article therefore has two objectives: firstly, to describe in detail the design, implementation process and pedagogical characteristics of the experience; and secondly, to evaluate its impact on student perception and satisfaction based on data from the survey conducted. The paper is structured as follows: section 2 reviews the theoretical background and relevant literature on teaching statistics and experiential learning. Section 3 describes the institutional context and the design of the activity. Section 4 addresses the specific implementation of the experience, and sections 5 and 6 present the results and conclusions of the work, respectively.

Theoretical Framework

Concern about university students' attitudes towards statistics has a long history in the specialist literature. Since the earliest studies, such as those by Roberts and Bilderbeck (1980) and Wise (1985), numerous studies have documented the prevalence of so-called 'statistical anxiety'—understood as the set of feelings of concern, fear and unease that arise when encountering statistical content—and its negative impact on academic performance and willingness to use these tools in subsequent professional practice (Onwuegbuzie and Wilson, 2003; Cruise et al., 1985).
In the specific field of Economics and Business degrees, Garfield et al. (2008) identify the lack of real-world context as one of the most relevant factors explaining these negative attitudes. The authors point out that when students do not perceive the connection between the statistical procedures they learn and the problems they aspire to solve in their future careers, motivation declines sharply and learning tends to be reduced to superficial memorisation of formulas and algorithms—without conceptual understanding or the ability to apply them. This situation is particularly paradoxical when one considers that the demand for analytical skills by organisations has only grown in recent decades, driven by the proliferation and growing importance of data.
Added to this is another factor: statistics, unlike other disciplines, requires students to simultaneously integrate mathematical skills, reasoning ability, and the ability to understand results. This multidimensionality of statistical learning makes conventional teaching strategies insufficient for developing a genuine understanding of the discipline (Biggs et al., 2022).
Considering the theory of experiential learning, Kolb (1984) proposes that learning occurs through a cycle that integrates concrete experience, reflective observation, abstract conceptualisation, and active experimentation. From this perspective, the mere transmission of theoretical content is insufficient: for meaningful learning to occur, students must have the opportunity to experiment, reflect and apply the concepts that give them meaning.
The application of this approach to different degree subjects, including statistics, has given rise to an approach that includes strategies such as the use of projects with real data, the incorporation of case studies, and even the invitation of professionals from outside the classroom (Cobb, 1992; Chance and Rossman, 2006). In all these cases, the common element is the contextualisation of learning in situations that reproduce, faithfully, the real conditions in which students will have to use statistical knowledge once they enter the labour market.
Biggs et al. (2022), in their proposal for constructive alignment, emphasise precisely the importance of designing learning activities that align with expected learning outcomes and assessment methods. In the case of Statistics Applied to Economics and Business, this implies that teaching activities should reproduce, as far as possible, the type of reasoning expected of a professional in the field: knowing how to identify the problem, select the necessary data, apply the appropriate statistical method, and interpret the results in economic or business terms.
The literature on the participation of external experts in university teaching yields consistently positive results, although it also raises some methodological cautions that should be kept in mind. Coleman (2013), in a study focusing specifically on the presence of professional statisticians in higher education classrooms, concludes that this strategy helps to increase student motivation, improve their understanding of the practical relevance of statistical content, and reduce the gap between academic

training and the demands of the labour market. The author stresses, however, that the impact depends largely on the degree of curricular integration of the activity: isolated interventions, without explicit connection to the course content, tend to produce more superficial and shorter-lasting effects.
Similarly, Ormrod (2004) points out that exposing students to professional models activates learning mechanisms that reinforce both motivation and perceived self-efficacy. From the perspective of social cognitive theory (Bandura, 1986), observing a professional who applies statistical tools to solve real economic problems can help students construct a more concrete and manageable representation of statistics, which in turn can have positive effects on their willingness to invest effort in learning.
More recently, Kirby and Turner (2024) analysed the impact of guest speakers—both in-person and virtual—in the context of business degrees, confirming that their well-planned incorporation, aligned with the course objectives, produces significant improvements in students' perception of the usefulness of the content and their own ability to apply it. The authors identify the following factors, among others, as key to success: the suitability of the expert's profile to the disciplinary context of the course, the structuring of the intervention around specific cases or problems, and the possibility for students to interact with the expert through questions or guided exercises.
These findings are consistent with the principles of instructional design based on situated learning theory (Lave and Wenger, 1991), which emphasises the importance of learning through authentic practices or, at least, in environments that realistically reproduce their essential characteristics. The participation of an active professional in the university classroom creates, albeit temporarily, a zone of contact between the academic community and the professional community.

Experience Design

The experience described in this paper was developed within the framework of the ‘Professionals in the Classroom’ initiative, promoted by the University of Oviedo with the aim of enriching the training of university students by incorporating experts from the professional world into the ordinary dynamics of undergraduate courses. This initiative responds to a widely shared concern in the Spanish university system about the need to strengthen links between universities and the labour market, in line with the recommendations and guidelines for competency-based learning.
The programme establishes an organisational framework that facilitates collaboration between university lecturers and external professionals, regulating aspects such as the selection of experts, coordination prior to the activity, the integration of the intervention into the curriculum and the evaluation of results. Participation in the initiative is voluntary for teaching staff, who propose experts based on the most appropriate profile for the content and objectives of their subjects; the institution, for its part, provides the necessary administrative and communication support and manages the formal recognition of the collaboration of external professionals.
The subject on which the experiment was implemented is Introduction to Economic Statistics, a compulsory subject taught in the first years of several undergraduate degrees in Economics and Business at the University of Oviedo. The main objective of the course is to provide students with the fundamentals of statistical reasoning and basic descriptive and inferential methods, with special attention to their application in the analysis of economic and business phenomena. Its placement in the first years of the degree programmes makes it a particularly sensitive subject from the point of view of student attitudes: students often arrive with negative expectations or a limited perception of its relevance to their education and professional future.
The activity took place during the 2024-2025 academic year and was coordinated by the teaching staff responsible for the subject. The selection of SADEI as a collaborating institution was based on criteria of both thematic relevance—SADEI is the statistical body of reference for the Asturian economy and produces and disseminates a wide range of official statistics of direct relevance to regional economic analysis—and institutional and territorial proximity, factors that reinforce the connection between the course content and the economic environment in which students are likely to develop their professional activity.
The design of the experience was geared towards achieving four main objectives, derived both from the analysis of the students' needs and from the principles of experiential learning reviewed in the previous section. Firstly, the aim was to increase students' motivation to learn statistics by showing them in a direct and observable way the relevance of this discipline in the daily professional practice of a professional statistician. Secondly, it sought to illustrate recent developments in the use of data and applied statistical analysis, with reference to official statistics and their role in economic and public policy decision-making. Thirdly, the activity sought to strengthen students' perception of the practical usefulness of the course content, establishing explicit links between the statistical methods explained in

the course and their applications in business and public administration contexts. Finally, the aim was to offer students an initial approach to the type of decisions, dilemmas and reasoning that characterise the work of a statistics professional, thus contributing to the construction of an emerging professional identity.
The activity was organised around three main blocks that combined the transmission of information with the active participation of the students. The first block consisted of an introductory lecture by the guest speaker, focusing on presenting the role of official statistics in the economic information system—with special attention to the statistics produced by SADEI on the Asturian economy—and illustrating through specific examples how statistical indicators are used in business decision-making, territorial planning, and public policy design. The main purpose of this block was to establish the frame of reference and motivate students by directly connecting the statistical concepts of the subject with their real-world applications.
The second and third block took the form of practical workshops. In the second, a business decision-making scenario was presented that required the interpretation of fictitious statistical data, so that students could experience, in a guided manner, the process of statistical analysis applied to a specific management problem. The third block replicated this dynamic in the public sector using real data, employing regional economic development indicators to illustrate the logic of statistical analysis in the context of public policy evaluation.
The activity was specifically designed so that each of its three blocks would be linked to the specific content of the course programme, enabling students to clearly identify the correspondence between what they had learned in the regular classroom and what they observed in the expert's intervention. This curricular alignment, which the literature identifies as one of the determining factors for the success of this type of experience (Coleman, 2013; Kirby and Turner, 2024), was coordinated prior to the activity between the teacher responsible for the subject and the guest professional.

Experience Implementation

Firstly, prior to the session, the teaching staff informed the students about the activity, contextualizing it within the framework of the ‘Professionals in the Classroom’ initiative and establishing an explicit connection with the subject's syllabus. The aim of this preliminary presentation was to prepare the students cognitively and motivationally, activating the prior knowledge necessary to take advantage of the intervention and generating positive expectations about the usefulness of the experience.
The session took place during the regular class time, without the need to modify the weekly course schedule. This integration into the usual classroom dynamics—unlike extraordinary activities that require travel or schedule changes—facilitated student participation. The first block, which was expository in nature, was conducted in a participatory manner that allowed students to ask questions and participate in the debate on the applications of official statistics. The guest speaker presented the SADEI's system for producing and disseminating statistics in an accessible and contextualised manner, illustrating the use of this data in the analysis of the Asturian economy with specific cases and projecting visualisations and statistical tables that the students were able to compare with the types of representations worked on in the regular classes for the subject.
The two practical workshops that made up the second and third blocks were organised around materials prepared specifically for the occasion, based on data provided by SADEI. In the business decision-making workshop, students worked with sectoral indicators and regional economic activity data to inform a series of business management decisions. On the other hand, in the public sector workshop, labour market, demographic and social welfare indicators were used to illustrate the process of evaluating a regional public policy measure. In both cases, the guest professional guided the analysis, pointed out the limitations of the data, and introduced practical considerations—regarding the availability, frequency of updates, and comparability of statistics—that significantly enriched the more formal analysis worked on in the course.
A distinctive feature of the implementation was the care taken in the interaction between the guest professional and the students. Far from adopting a one-way lecture format, the session actively encouraged questions, case discussions, and the exchange of views on the implications of the data presented. This dynamic was consistent with the available evidence on the formats of external expert interventions that have the greatest impact on learning (Kirby and Turner, 2024).
Finally, as an evaluation of the experience, participating students had to respond to a satisfaction survey structured around four main items: overall satisfaction with the Professionals in the Classroom activity, satisfaction and usefulness of the content covered, satisfaction with the external expert's presentation, and assessment of the usefulness of the expert's visit. Each item was rated on a numerical scale from

0 to 10, and there was also the option to add open-ended qualitative comments. The survey was administered through the University of Oviedo's institutional platform, which guaranteed the anonymity of the responses and facilitated data collection and processing

Experience Results

The satisfaction survey was completed by students from various groups on the course 'Introduction to Economic Statistics' across different Economics and Business degree programmes, all of whom took part in the activity described. Although the sample size is small—a factor that limits the generalisability of the results and which will be discussed in greater detail in the section on limitations—the data obtained provide valuable information on the perceptions of the participating students and are consistent with the findings of similar studies in the specialist literature (Coleman, 2013; Kirby and Turner, 2024).
The participants came from different groups within the course, taught by different lecturers, which brings a degree of diversity to the sample and allows for the possibility that the assessments reflect perceptions that are relatively independent of the specific classroom context. The survey was completed on a voluntary and anonymous basis, which minimises social desirability bias.
The results of the satisfaction survey are set out in Table 1, which presents the basic descriptive statistics—minimum value, maximum value and arithmetic mean—for each of the four items assessed.

Table 1. Descriptive statistics from the satisfaction survey (0–10 scale)

Item	Min	Max	Mean
Overall satisfaction with the activity	5	10	8.44
Satisfaction with and usefulness of the content	4	10	8.00
Satisfaction with the expert's presentation	8	10	9.33
Benefits of having an external expert visit	5	10	8.11

Source: own elaboration.

The data reveal that students have rated the experience very positively. Firstly, overall satisfaction with the 'Professionals in the Classroom' initiative averages 8.44 out of 10, with scores ranging from 5 to 10. This average score, which far exceeds the threshold for high satisfaction, is consistent with the results reported in similar studies on initiatives to bring external professionals into the university classroom (Coleman, 2013; Kirby and Turner, 2024) and suggests that the activity was perceived as an experience of significant added value by the majority of participating students.
Secondly, satisfaction with the usefulness and the content covered has an average score of 8.00, with a slightly wider range (4–10) than the other items. This wider range could be interpreted as indicative of greater variability in students' perceptions of the relevance of the content—variability that could be related to differences in prior statistical knowledge, the class group of origin, or individual expectations regarding the activity. However, the resulting average remains high and allows us to conclude that the content was rated positively by the participating students.
The item receiving the highest average score is, significantly, satisfaction with the guest expert's presentation, with an average of 9.33 points and a range of 8 to 10. This result is particularly significant for several reasons. On the one hand, it confirms the importance of the external expert's profile and communication skills as a determining factor in the success of this type of experience, in line with the methodological recommendations in the literature (Coleman, 2013). On the other hand, the high consistency of the ratings—all students awarded a score of 8 or higher—suggests that the quality of the SADEI professional's presentation was consistently perceived positively by the student body, regardless of other contextual variables.
Finally, the usefulness of the external expert's visit received an average score of 8.11 -range (5–10)-. The relative proximity of this item to those concerning overall satisfaction and satisfaction with the content suggests that the assessment of usefulness is consistent with overall satisfaction, with no significant discrepancies observed between the two dimensions. This pattern, moreover, is common in the literature on the evaluation of innovative teaching experiences (Biggs et al., 2022).
A combined analysis of the four items allows us to draw some interesting conclusions regarding the impact of the experience. Firstly, it is noteworthy that the most highly rated aspect—the expert's presentation—is precisely the one that most directly embodies the experiential component of the activity: the opportunity to observe and listen to a practising professional who applies statistics in her day-to-day work. This result supports the hypothesis, well-established in the literature, that exposure to professional role models constitutes a highly effective mechanism for motivation and learning in the context of quantitative disciplines (Ormrod, 2004; Bandura, 1986).

Secondly, the relatively low minimum scores for the items relating to satisfaction with the content and the usefulness of the visit—4 and 5, respectively—suggest that a minority of students did not perceive the activity as particularly useful or relevant. Although the small sample size prevents definitive conclusions from being drawn about the causes of this variability, some plausible hypotheses can be suggested: the possibility that some students attended the session with expectations that were not well aligned with its design, the influence of the group context, or individual differences in interest in applied statistics versus methodological statistics.
Thirdly, the overall consistency of the results with the findings in the specialist literature—and in particular with the work of Coleman (2013) and Kirby and Turner (2024)—lends credence to the interpretation that the positive ratings reflect a genuine impact of the activity on students' motivation and perception of its usefulness, rather than merely a novelty effect or a courtesy response. The robustness of this impact, however, can only be rigorously assessed by tracking the attitudes of participating students over time and comparing them with control groups, which constitutes a particularly interesting avenue for future research.

Conclusions

This paper has described and evaluated an experiential learning initiative within the 'Introduction to Economic Statistics course at the University of Oviedo, centred on the participation of a professional statistician from SADEI as part of the 'Professionals in the Classroom' initiative. The results of the satisfaction survey conducted among the participating students are consistently positive, with averages exceeding 8 out of 10 across all assessed items and a particularly high score for satisfaction with the expert's presentation (M=9.33).
These results suggest, firstly, that bringing external professionals into the university classroom—when done in a planned manner, with appropriate alignment with the curriculum and careful coordination between the lecturer and the guest expert—constitutes an effective strategy for increasing students' motivation to learn statistics and for strengthening their perception of the practical usefulness of the course content. Secondly, the experience illustrates the viability and relevance of the experiential learning approach in Economics and Business degree programs, where the integration of theoretical training and professional practice is a priority pedagogical objective. Thirdly, the University of Oviedo's 'Professionals in the Classroom' initiative proves to be a suitable institutional framework for the development of this type of experience, as it provides the organizational support and formal recognition necessary to ensure that collaboration between university teaching staff and external professionals is sustainable and systematic.
From a curriculum design perspective, it therefore seems advisable that this type of activity should not be viewed as a one-off, exceptional intervention, but rather as a regular component of teaching planning in applied statistics courses—and, more generally, in quantitative subjects that aim to develop analytical skills directly transferable to the labour market. The systematization of the experience, the consolidation of collaborative networks with local institutions and businesses, and the progressive refinement of the pedagogical design constitute, in this regard, the pillars upon which the future development of the initiative should be structured.
The study does, however, have limitations that should be acknowledged: the small sample size limits the generalisability of the results—although their consistency with the literature lends them plausibility—; the absence of a control group prevents the specific effect of the intervention from being isolated from other contextual factors; and the immediate nature of the survey does not allow for an assessment of the long-term impact on learning or the transfer of statistical skills to new contexts.
Finally, it is worth noting that beyond the specific context of Economic Statistics, the experience described in this study offers elements that can be transferred to other quantitative disciplines within social science degree programmes—such as Financial Mathematics, Econometrics or Data Analysis—where the gap between theoretical training and professional practice poses similar pedagogical challenges. The systematisation and dissemination of these experiences, within the framework of institutional initiatives such as the one described, constitute a significant contribution to the advancement of teaching innovation in higher education.

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From Abstraction to Story: AI-Generated Comics for Teaching Probability

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Abstract

Teaching probability in Economics and Business degrees is a well-documented challenge. The core difficulty is not so much the technical complexity of the models themselves, but the gap between what students already know from everyday experience and the abstract notation they are suddenly expected to handle.
This project proposes using AI-generated comic panels as a cognitive bridge between familiar situations and formal probabilistic reasoning. Before introducing each probability model, students are shown a brief visual scene which represents a recognisable economic or everyday situation that embodies the model's logic. This is followed by a guided discussion in which they identify the random element, and only then is the formal model introduced. The sequence, repeated at the start of every thematic block throughout the semester, follows a scene → idea → formalisation structure and is applied in several statistics courses at the University of Oviedo and the University of León. The visual materials are produced using generative AI tools, which makes it feasible to customise them to the economic context of each course and to update them without relying on professional illustration. The paper describes the theoretical basis of the approach, the production and implementation methodology, and the evaluation system planned to assess its impact beyond student satisfaction.
The expected outcomes include fewer errors in model identification, greater willingness to engage with mathematical notation, and improved performance in exam questions related to probability distributions. A teaching protocol summarising the design criteria, implementation steps and evidence-based recommendations will be published at the end of the project to allow other instructors to replicate the methodology in their own quantitative courses.

Keywords: *generative AI, educational comics, probability models, teaching innovation, statistics education.*

1. Introduction

The teaching of statistics in Economics and Business degree programmes faces a persistent challenge: its high level of abstraction. This challenge is particularly acute in advanced courses, where students encounter cognitive barriers that lead to stress and disengagement. In quantitative subjects, interest and perceived value decline over the course of the semester, reinforcing the need for methodologies that stimulate motivation from the outset [11]. Added to this is the fact that probabilistic concepts generate a high cognitive load due to their limited intuitive connection with real-life situations [1]. Many errors stem precisely from the lack of an intuitive representation of the random phenomenon, which underlines the importance of supporting understanding before formalisation.
The literature on economics education highlights that the use of cartoons and comics reduces anxiety and encourages more participatory learning [2]. Comics transform complex theories into visual narratives and trigger a mode of reasoning based on spatial metaphors and graphic sequences [5]. Depicting everyday scenes with humour forces students to link the situation to the concept, promoting higher-order reasoning [9]. In probability, this approach helps to develop intuition: visualising, for example, the logic of a uniform distribution allows one to 'see' the behaviour before encountering the formal notation.
This project proposes using generative artificial intelligence (AI) to create cartoons tailored to the economic and probabilistic context without the need for professional illustration.
The paper is structured as follows. Section 2 reviews the relevant literature. Section 3 describes the project design and implementation methodology. Section 4 discusses the evaluation system and expected results. Section 6 concludes.

2. Theoretical Framework

Teaching probability models at university level involves a dual cognitive demand: students must simultaneously build a mental representation of the random phenomenon and map that representation onto a formal language of notation, parameters and conditions of application. When the first step is missing, the second becomes an exercise in rote memorisation rather than genuine comprehension. Research in statistics education consistently shows that the most common errors in probability tasks are not algebraic mistakes but failures of identification: students cannot recognise what type of random structure a given situation embodies and therefore cannot select or apply the appropriate model [1].

This pattern is consistent with the broader cognitive load framework: abstract notation imposes a high extraneous load that competes with the germane processing needed for understanding. The implication for instruction is that reducing the abstraction barrier at the point of first contact with a model, before formalisation begins, is likely to free cognitive resources and improve comprehension. This is precisely the role that visual and narrative resources can play: not as a substitute for formal content, but as preparation for it. Cladera et al. [11] found that student attitudes towards quantitative subjects deteriorate over the course of the semester, which reinforces the importance of engaging students from the very first contact with each new topic.

Comics and cartoons have a reasonably established place in the educational literature, particularly for subjects where abstraction and student anxiety tend to coincide. Van Wyk [2] showed, in an economics education context, that cartoons reduce anxiety and create more participatory classroom dynamics. The argument is not simply motivational: Groensteen [5] points out that the grammar of comics, the sequencing of panels, the interplay of image and text, and the use of spatial metaphors, activates a form of inferential reasoning that mirrors the logic students need in order to understand probabilistic mechanisms. A well-designed scene prompts the reader to ask what is varying, why, and what the likely outcomes are, which are exactly the questions that make probabilistic reasoning work.

Depicting an everyday situation with a degree of humour or exaggeration forces students to link what they see to the underlying concept, which promotes higher-order reasoning and improves retention [9]. In engineering education, Karimi et al. [4] found that comic-based scientific storytelling facilitates the transfer of technical content and increases motivation among university students. Bestil and Punla [3] demonstrated, in a secondary education setting, that digitised comics specifically designed for probability of random variables improved problem-solving performance and significantly reduced mathematics-related anxiety. Works such as The Cartoon Guide to Statistics [6] have long shown that statistical ideas can be communicated visually without sacrificing rigour, and that accessible presentation does not imply a lower ceiling for understanding.

Despite this evidence, the integration of comics into university-level probability instruction has remained scattered. Most documented cases involve isolated resources rather than a systematic use across a complete course, and none has been designed specifically around a structured sequence of probability models. Martin [10] adds a further relevant consideration: the quality of visual learning materials depends heavily on their design, specifically on whether they have an explicit purpose, avoid ambiguity, and focus attention on a single central idea. This suggests that the effectiveness of comic-based resources is not automatic, but contingent on thoughtful instructional design.

The practical barrier to using customised comics in university teaching has historically been the cost and expertise required to produce them. Generative AI tools, such as ChatGPT, Copilot or Gemini, substantially lower this barrier: they can generate images of reasonable quality from textual descriptions in a matter of minutes, without requiring graphic design skills. Kasneci et al. [7] and the UNESCO guidance on AI in education [8] both acknowledge the potential of these tools for producing flexible, low-cost visual materials at scale, while noting that their effective use depends on instructor judgment in the design and selection of outputs.

Eapen et al. [9] describe a concrete workflow for creating AI-generated educational cartoons: the critical step is writing a precise narrative brief before engaging with the tool. This brief must specify the situation to be depicted, identify the random element clearly, and set the intended tone. The AI handles the illustration; the pedagogical content is determined entirely by the instructor. This distinction is important because it means that generative AI does not replace the instructional design process, it accelerates the production step once that process has been completed. The result is a scalable approach to material creation that was not previously available to standard teaching teams operating without dedicated illustration resources.

3. Project Design and Implementation

The project's methodology is based on a structured process that combines the design of visual materials using artificial intelligence, their phased integration into the classroom, and a monitoring system that enables the assessment of their effectiveness and the improvement of the resource for future academic years. The aim is for the illustrations to serve as an intuitive aid that facilitates the understanding of probability models, without replacing the formal content, but rather preparing students for it and making it more accessible.

3.1 Design and Conceptualisation Phase

We begin by identifying the probability models that typically present the greatest difficulty: binomial, geometric, hypergeometric, Poisson, exponential, uniform and normal. For each model, very brief narrative scripts are developed to translate the essence of the probabilistic behaviour into everyday or economic scenarios that are easily recognisable to students. This step is fundamental because it establishes the conceptual 'entry point' that will later allow the visual story to be linked to the mathematical formulation of the model.
In this phase, the quality criteria for the vignettes are also defined: visual clarity, absence of distracting elements, representation of a single central idea, and an accessible tone. These criteria serve as a guide for all subsequent iterations and ensure the aesthetic and pedagogical coherence of the whole.

3.2 Generating Content Using AI Tools

Once the scripts have been finalised, we will proceed to create the panels using various generative AI tools (such as ChatGPT, Copilot or Gemini). We will experiment with several platforms to compare graphic styles, clarity, the expressiveness of the scenes and narrative suitability. This comparison is particularly important in an innovation project, as it allows us to make an informed choice as to which tool produces illustrations that are clearer, more comprehensible and more useful for our objectives.
After generating different versions, the team will select the vignettes that best convey the idea associated with each probabilistic model. Aspects such as the balance between detail and simplicity, the ease with which the random element of the scene can be identified, and the extent to which the situation might be recognised by economics and business students will be reviewed. The final result will be a library of vignettes classified by model, reviewed and prepared for implementation in the classroom [Figures 1 & 2].



Fig. 1. AI-generated comic strip illustrating the Geometric distribution: repeated Bernoulli trials until the first success. Source: own elaboration using generative AI (2026).

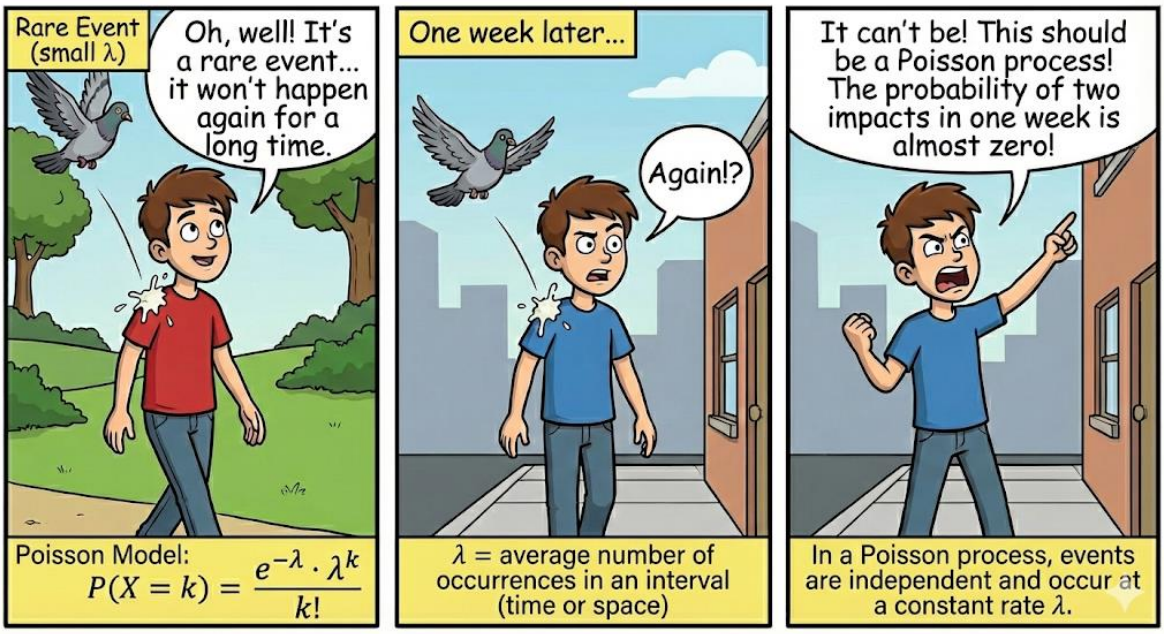


Fig. 2. AI-generated comic strip illustrating the Poisson distribution: counting the number of events occurring in a fixed interval of time. Source: own elaboration using generative AI (2026).

3.3 Integration into Teaching: A Clear Teaching Routine

The use of the vignettes will follow a consistent and recognisable sequence in the classroom. At the start of each section devoted to a probabilistic model, the lesson will begin with the projection of the relevant vignette. This opening serves to activate prior knowledge, spark curiosity and focus attention on a concrete, relatable example.

This will be followed by a brief guided discussion in which pupils will be invited to identify which element of the scene is random and how the phenomenon might be represented. This intuitive identification facilitates the transition to the formal explanation, which is introduced immediately afterwards. The corresponding model, already covered in the syllabus, will then be presented, and its applications will be explored through practical exercises, tables, calculations or interpretations. This integration allows for a direct assessment of the usefulness of the vignettes in the initial identification of probabilistic models and in the transition towards formalisation.

The vignette thus acts as a bridge between the everyday and the abstract. Its aim is not to teach the model in itself, but to create a mental framework that allows the formal explanation to be understood with less cognitive effort and a stronger connection to reality.

3.4 Digital Support and USE on the Virtual Campus

After each session, the comic strips will be published on the Virtual Campus, organised by model. Students will be able to access them to revise the topics, reinforce conceptual associations and recall the logic behind each block. This presence on the Virtual Campus makes the cartoon an accessible and reusable resource throughout the semester, serving as a visual aid for independent study and exam preparation. This digital organisation ensures the sustainability of the resource and facilitates its subsequent adaptation to new subjects.

3.5 Monitoring and Data Collection via a Questionnaire

The monitoring of the project will be based on the students' own feedback. To this end, a questionnaire will be created using Google Forms, published on the Virtual Campus and announced in class. The questionnaire will be brief and anonymous, and will include questions on:

– The perceived usefulness of the diagrams in understanding the model before tackling the formal aspects.

– The clarity of the scenes and whether they have helped students connect better with the examples covered in the exercises.

– Suggestions for improvement for future editions (level of detail, length of captions, context of the stories, etc.).

– Preference regarding the format of the cartoons: whether simpler cartoons without formulas are preferred, or cartoons that already incorporate some mathematical elements.

The data will be analysed to identify patterns, opportunities for improvement and possible adjustments to the design of the scenes or the way they are integrated into the class.

3.6 Analysis of Results

The information gathered will be used to refine the design of the vignettes for the next course. This feedback phase will enable us to identify which models have caused the most confusion, which scenes have worked best, and which visual elements are most or least effective for the students. The methodology thus provides for a cycle of continuous improvement, which is a central feature of the project's innovative nature.

4. Evaluation System

The assessment procedure consists of three stages:

a) During implementation.

Each time a case study is used in the classroom, a practical check will be carried out to ascertain whether students are able to intuitively identify the probabilistic situation depicted and whether the transition to the formal model is made smoothly. This will be assessed through brief, ad hoc checks (short questions, identification of the appropriate model or brief summaries).

b) At the end of the probability module.

Once the probability models for the semester have been covered, a questionnaire will be distributed via Google Forms through the Virtual Campus. This questionnaire will gather information on clarity, usefulness and format preferences, as well as suggestions for improvement.

c) Final course assessment.

At the end of the academic year, a comparative analysis will be carried out of performance on the final exam questions relating to probabilistic models, comparing the results with those obtained in previous years. This analysis will enable us to assess whether the vignettes have had a real and measurable impact on the understanding and application of the models. Data from the student questionnaire will also be incorporated to obtain a complete picture of the resource's effectiveness.

5. Expected Results

The proposed use of AI-generated vignettes is expected to enhance students' engagement with probability models by reducing the initial abstraction barrier that typically hinders understanding. By introducing each model through a familiar and visually grounded situation, the approach aims to activate intuition before formalisation and thus provide a more accessible entry point into the mathematical content.
In terms of learning outcomes, the main expected effect concerns students' ability to correctly identify probabilistic structures. The visual representation of each situation is intended to support recognition of the underlying random mechanism, which should in turn improve the selection and application of the appropriate model in exercises and problem-solving tasks. Consequently, a reduction in frequent errors, such as confusion between distributions or misinterpretation of problem statements, is anticipated.

At the classroom level, the use of vignettes is also expected to foster a more participatory learning environment. The initial interpretation of the scene creates a natural space for discussion, encouraging students to articulate hypotheses and connect the visual narrative with prior knowledge. This interaction is likely to facilitate a smoother transition towards formal explanation and to reinforce collaborative reasoning.
Beyond the classroom, the availability of the vignettes on the Virtual Campus is expected to support independent study. By functioning as visual reference points, the materials may help students recall the logic associated with each model and organise their understanding more effectively over time. In this sense, the vignettes can act as cognitive anchors that strengthen retention in the medium and long term.
A further expected outcome relates to students' confidence when dealing with probabilistic content. Approaching formal notation through an initial intuitive representation may reduce the perceived difficulty of the subject and contribute to greater self-efficacy, as well as to a more positive attitude towards quantitative methods.
Finally, these combined effects are expected to translate into measurable improvements in academic performance, particularly in assessment tasks related to probability distributions. A comparison with results from previous academic years will provide an empirical basis to evaluate whether the integration of vignettes has contributed to a more consistent and accurate application of probabilistic models.

6. Conclusions

This paper presents the design of a teaching innovation project that addresses a well-documented problem in statistics education: the abstraction barrier that prevents many students in Economics and Business degrees from building a solid intuitive understanding of probability models before encountering their formal treatment. The proposed approach combines generative AI to produce customised visual materials with a structured pedagogical sequence, scene → idea → formalisation, that is applied consistently at the start of each thematic block. The result is a replicable teaching routine grounded in the literature on cognitive load, visual reasoning and statistics education.
The evidence reviewed in Section 2 supports the two-core premises of this project: that activating intuition before formalisation reduces cognitive load and improves comprehension [1], and that comics and visual narratives are an effective vehicle for that activation in subjects where abstraction and student anxiety tend to reinforce each other [2] [3] [4]. What generative AI adds to this picture is not a new pedagogical principle, but a practical solution to a production problem that has historically limited the scalability of visual approaches in university teaching.
The expected outcomes described in Section 5, fewer errors in model identification, greater engagement with formal notation, and improved exam performance, will be evaluated through the comparison of results across cohorts and through student feedback collected via questionnaire. Whether or not the data confirm these expectations, they will contribute empirical evidence to a field where systematic studies at university level remain scarce, particularly on the specific challenge of teaching discrete and continuous probability distributions to non-specialist audiences.
Beyond the immediate context, the teaching protocol that will be produced at the end of the project is intended to make the methodology transferable to other quantitative courses and institutions, without requiring prior expertise in AI or graphic design. In this sense, the project's contribution is not only the set of materials generated, but the documented process for producing and using them, which other teaching teams can adapt to their own disciplinary context.

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Peer Collaboration and Generative AI Interaction: Assessing Student Agency in Project-Based Programming

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Abstract

Generative artificial intelligence (GenAI) and large language models are increasingly integrated into project development processes; however, limited empirical evidence explains how students preserve agency when working concurrently with peers and AI systems. This qualitative study examined how associate degree students positioned GenAI during a project-based programming course and how individual and collective agency emerged in this context. The study group consisted of 42 students enrolled in a Computer Programming Program at a vocational school in Türkiye in 2026. The students developed software projects in 14 collaborative groups over a 14-week Professional Project course. The data were collected through an open-ended questionnaire addressing students' experiences of AI use, decision-making, cognitive support, and collaboration. The data were analyzed through directed content analysis, informed by the concepts of human-AI co-agency, student agency, cognitive scaffolding, and collaborative learning. The findings indicated that students predominantly positioned GenAI as a teammate or mentor rather than as a merely technical tool. They associated AI support mainly with scaffolding, reflective dialogue, and cognitive load reduction. Although AI was used extensively, the students reported that final decisions were generally made through group discussion, critical questioning, verification, and independent judgment. Most participants preferred a hybrid collaboration model that combined AI support with peer interaction. These findings suggest that, when embedded in a pedagogically structured project-based learning environment, GenAI can support problem-solving / project-based programming / project-based learning and collaborative work without necessarily diminishing students' agency. The study offers implications for designing human-centered AI-supported learning environments that maintain learners' responsibility, critical engagement, and collective decision-making.

Keywords: *Generative AI; Project-Based Learning; Student Agency; Collective Agency; Programming Education; Human-AI Co-agency*

1. Introduction

The rapid development of Generative AI (GenAI) and Large Language Models (LLMs) has fundamentally transformed the nature of student-technology interaction in educational settings [1]. These systems are no longer used merely as passive repositories of information; rather, they increasingly function as conversational resources and adaptive control subsystems that actively intervene in the learning process. Shifting from a static tool-user relationship toward a dynamic cognitive partnership [2], [3], AI agents now support complex tasks such as ideation, code testing, debugging, and the refinement of project outputs.

This transformation is particularly relevant for Project-Based Learning (PBL), where students are expected to engage in authentic problems, negotiate ideas with peers, and construct solutions through iterative inquiry and production. When integrated into these environments, AI agents move beyond static utility. They serve as capable peers providing cognitive scaffolding [4], [5], act as teachable models [6], [7], and function as metacognitive regulators that promote socially shared regulation of learning [8], [9]. In AI-supported PBL environments, a central educational issue is not simply whether GenAI can produce technically accurate responses, but whether students remain active agents in the learning process. Student agencies refer to learners' capacity to take initiative, make informed decisions, evaluate information critically, and assume responsibility for learning outcomes. Previous studies suggest that AI can provide cognitive scaffolding, reduce procedural burdens, lower the fear of failure, and promote reflection in collaborative contexts [10], [4], [5]. However, this introduces a significant tension: over-reliance on AI systems may weaken critical engagement, cause "production blocking" through over-mediation, and shift epistemic authority from learners to automated outputs [11], [2], [12]. Thus, the

educational value of GenAI depends substantially on how learners position and regulate it within their learning activities.
This issue becomes more complex in collaborative PBL settings, where agency is distributed across individual learners, peers, tools, and shared routines. Depending on whether students perceive GenAI as a tool, a mentor, or a teammate, their patterns of collaboration, evaluation, and decision-making differ. This aligns with the "cognitive co-agent" model, which emphasizes human-AI co-agency; knowledge construction must emerge through interaction, interpretation, and selective integration rather than through passive acceptance of AI-generated content [13], [14]. Students are required to navigate "epistemic entanglement" [15], treating AI outputs as dialogic material to be interrogated [16]. However, working autonomously with AI risks eroding shared ownership and peer solidarity central to PBL, necessitating that teachers design pedagogical structures where AI enriches rather than replaces peer collaboration [17].
Despite the explanatory power of traditional constructivist frameworks, they struggle to account for systems that actively shape arguments in real time [18]. Furthermore, empirical evidence remains limited regarding how students negotiate this delicate balance of agency and collaboration in programming projects. Accordingly, this study investigated students' experiences of GenAI use in a project-based programming course. Employing a qualitative approach to analyze student interactions and responses, the study addressed three research questions: (a) How do students position GenAI during project development? (b) What forms of cognitive support do students attribute to GenAI? (c) How does student agency manifest during decision-making and collaboration with peers and AI?

2. Method

2.1 Research Design

This study employed qualitative research design. Directed content analysis was used because the analysis was guided by existing theoretical constructs related to human-AI co-agency, student agency, cognitive scaffolding, and collaborative learning [7]. This approach enabled the use of conceptually informed initial codes while allowing additional meanings to emerge from students' written responses.

2.2 Participants and Context

The participants were 42 associate degree students enrolled in the Computer Programming Program at Yüksek İhtisas University Vocational School in Türkiye in 2026. The study was conducted within a 14-week Professional Project course structured according to PBL principles. The students worked in 14 project groups and used GenAI tools during software development. Criterion sampling was used to include students who actively participated in group work, used GenAI during project development, and volunteered to share their reflections.

2.3 Data Collection and Analysis

Data were collected through an open-ended questionnaire developed by the researchers. The first section included demographic items related to gender, programming experience, prior PBL experience, and prior AI-use experience. The second section consisted of seven open-ended questions focusing on students' perceptions of AI, decision-making processes, collaboration experiences, and agency. The responses were transferred to MAXQDA 24 and coded under four thematic areas: role-oriented positioning, functional cognitive support, agency indicators, and collaboration preferences. Code definitions were reviewed collaboratively, disagreements were resolved through discussion, and interpretations were supported by participant statements. Direct participant quotations were included to enhance the reliability of the findings, and the participants were coded as P1, P2, P3... P42.

3. Findings

The findings are presented under five areas: participant characteristics, students' positioning of GenAI, cognitive support attributed to GenAI, agency indicators, and collaboration preferences.

Table 1. Demographic Characteristics of Participants

Variable	n	%
Female	11	26.2
Male	31	73.8
Programming experience: 0-6 months	8	19.0
Programming experience: 6-12 months	3	7.1
Programming experience: 1-2 years	26	61.9
Programming experience: 2 years or more	5	11.9
Previous PBL experience: Yes	17	40.5
Previous PBL experience: No	25	59.5
Previous AI-use experience: Yes	38	90.5
Previous AI-use experience: No	4	9.5

Table 2. Students' Positioning of Generative AI

Code	f
Teammate	24
Mentor	21
Tool	3

As shown in Table 2, students most frequently described artificial intelligence as a teammate (f=24) and a mentor (f=21); very few considered it merely a tool (f=3). This indicates that students view AI not as a passive technology, but as an active participant contributing to the project development process.

Participant statements further support this finding. P15 highlighted AI's contribution to in-group collaboration by stating, "We asked our question and reached a joint decision by exchanging ideas among ourselves." Similarly, P16 noted that AI's suggestions were not accepted outright but were instead evaluated and refined by group members, stating, "We add our own interpretations to the AI's suggestions."

Students also defined AI as a mentor that guides the learning process. P37 stated, "It helped us understand and overcome the obstacles we faced as we advanced our process," while P40 noted, "It guided us, and we reached a solution with my friends."

Overall, the findings demonstrate that students position generative AI not simply as a technical tool that provides information, but as a collaborative learning partner offering guidance throughout the project development process. Student responses indicated that AI-generated suggestions were typically discussed, interpreted, and revised within the group before being incorporated into project decisions.

Table 3. Cognitive Support Attributed to Generative AI

Code	f
Scaffolding	37
Reflective dialogue	20
Cognitive load reduction	15

As indicated in Table 3, the students most frequently associated artificial intelligence with the scaffolding function (f=37). Furthermore, the functions of AI in fostering reflective dialogue (f=20) and reducing cognitive load (f=15) were also frequently emphasized by the students. This indicates that artificial intelligence provides various forms of cognitive support during students' learning and problem-solving processes.

Participant statements reveal that artificial intelligence assumes a guiding role, particularly in problem-solving. P32 highlighted the mentoring function of AI, stating, "It both provided hints and showed the way, and enabled us to notice some of our mistakes." Similarly, P41 noted that AI supported their progress, expressing, "By helping me at points where I got stuck while developing my project on my own, it accelerated my transition to the next stage."

Regarding AI's function of supporting reflective thinking, P41 stated, "By noticing the logic or syntax errors in the code I wrote and alerting me, it took on an interrogative role that enabled me to solve the problems on my own." This view demonstrates that artificial intelligence not only offers solutions but also actively supports students' thinking processes.

The students viewed artificial intelligence not as a source of ready-made information, but as a supportive element that helped them develop their own ideas. P36 summarized this perspective by stating:

"Artificial intelligence is not a source from which I consume ready-made information; rather, I blend the technical infrastructure it provides with my own logic and interpretation to prepare the solution step by step."
Overall, the findings demonstrate that generative artificial intelligence is evaluated by students not merely as an information-providing tool in their learning processes, but as a multidimensional cognitive support element that offers guidance, points out errors, encourages thinking, and facilitates the problem-solving process. Students emphasized that GenAI helped them identify errors, receive hints, and proceed to subsequent stages of design and development. Reflective dialogue was also evident, as the students reported using AI to reconsider their logic, syntax, and solution strategies rather than merely to obtain ready-made code.

Table 4. Student Agency Indicators in AI Interaction

Code	f
Group initiative	30
Group decision-making	29
Independent decision-making	22
Generating own ideas	19
Questioning	18
AI dependence	18
Verification	14
Alternative solution generation	11

As indicated in Table 4, students exhibited behaviors such as taking initiative, decision-making, questioning, verification, and independent thinking in their interactions with artificial intelligence. Group-level decision-making and initiative-taking were particularly prominent, demonstrating that students assumed active roles during the project development process. Additionally, independent decision-making, generating original ideas, and questioning artificial intelligence outputs emerged as notable findings. These results reveal that students did not completely surrender their cognitive responsibility to artificial intelligence.
Participant statements indicate that students utilized artificial intelligence not as a decision-making authority, but as a tool to support their thinking processes. P42 highlighted this approach, stating, "It made us more independent. Instead of taking ideas directly from artificial intelligence, we generated our own ideas and asked the AI for detailed feedback on the nature of our idea and how we could improve it." This perspective demonstrates that students sought to develop their own ideas rather than accepting ready-made solutions.
It was also observed that students critically evaluated the information provided by artificial intelligence. P2 indicated that they cross-referenced AI outputs with different sources, stating, "I did not use the responses directly; I compared them with other artificial intelligence tools to synthesize a single set of data." Similarly, P21 emphasized that the final decisions rested with the students, expressing, "Even though we received help from artificial intelligence, we proceeded according to our own thoughts on certain issues. We questioned the provided answers and selected the most appropriate one."
The findings indicated that agency was most visible through group initiative and group decision-making. The students also reported independent decision-making, idea generation, questioning, verification, and the development of alternative solutions. Although AI dependence appeared in 18 coded instances, it did not dominate the overall pattern. The findings indicate a form of hybrid agency in which AI support was used actively, while final responsibility remained largely with students and groups.

Table 5. Collaboration Preferences

Code	f
AI and group members together	36
Only AI	5
Only group members	2

Table 5 demonstrates that the vast majority of students prefer a collaborative working model that incorporates both artificial intelligence and group members. In contrast, the number of students who prefer to work exclusively with artificial intelligence or solely with group members is lower. This finding demonstrates that students prefer to utilize both the technical support provided by artificial intelligence and group interaction during the project development process.
Participant statements reveal that working alongside both artificial intelligence and group members offers distinct advantages. P14 highlighted the contribution of this joint effort, stating, "Gathering

information to evaluate it with my group mate, and accelerating the process by considering what we can add to that information and how much we can improve it."
Similarly, P26 indicated that artificial intelligence and group members complement each other, expressing, "Artificial intelligence alone is not highly efficient and may not yield the exact results we desire; however, alongside both artificial intelligence and my friends, we reached a more effective outcome." P37 expressed AI's contribution to faster and easier problem resolution, stating, "With the support of artificial intelligence for errors we could not understand, we solved the problem in a much shorter time than usual."
Overall, most students preferred a hybrid collaboration model that included both AI and group members. Students valued AI for rapid technical support and troubleshooting, while peers contributed interpretation, negotiation, contextual judgment, and shared responsibility. Thus, AI did not appear to replace peer interaction; rather, it was generally positioned as a complementary element within group work.

4. Discussion and Conclusion

The findings show that the students in a project-based programming environment tended to position GenAI as a teammate or mentor rather than as an inanimate software tool. This result is consistent with human-AI co-agency perspectives, which conceptualize knowledge construction as an interactive process involving human interpretation, dialogue, and selective integration of AI-generated outputs [13], [14]. In this study, AI suggestions were not simply accepted; they were brought into group discussions and evaluated collectively.
The study also demonstrates the role of GenAI as a cognitive support mechanism. By providing scaffolding and reducing cognitive load, AI enabled the students to address technical difficulties and focus on higher-level problem-solving / problem-based learning processes [10], [4], [5]. This contribution is especially relevant in programming education, where minor syntax or logic errors may interrupt students' progress. However, the findings suggest that AI support functioned primarily as a facilitating mechanism rather than as a substitute for students' own reasoning.
A central contribution of the study is its finding that extensive AI use does not necessarily diminish student agency. The participants reported generating original ideas, questioning AI outputs, verifying information, and retaining control over final decisions [2], [15]. Nevertheless, the occurrence of AI dependence indicates that AI use requires deliberate pedagogical structuring. Learning tasks should require students to justify how they evaluated AI suggestions, why they accepted or rejected them, and how group members contributed to final project decisions.
The findings also address concerns that AI use may isolate learners or weaken peer collaboration. Students' strong preference for a hybrid model suggests that they recognized the distinct contributions of AI and peers. In the observed context, AI supported collective agency by contributing to technical efficiency and reflective problem solving, while peer interaction sustained negotiation, accountability, and shared ownership.
This study is limited to 42 students from a single vocational school and relies on self-reported written reflections. Therefore, the findings should be interpreted as context-specific rather than generalizable to all programming or PBL environments. Future studies should triangulate open-ended responses with AI interaction logs, classroom observations, and project performance indicators. In conclusion, GenAI can support project-based programming education when it is embedded in learning designs that protect students' critical judgment, collaborative responsibility, and agency.

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Diagnostic Analysis of Students' Errors in Integral Calculus: Method Selection as a Source of Difficulty in Undergraduate Mathematics

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Abstract

Throughout several years of teaching Mathematical Analysis to first-year students in the Bachelor program in Informatics, we have observed that students encounter significant difficulties in selecting an appropriate integration method for a given problem. Our study aims to investigate the major difficulties related both to the selection of integration techniques and to the conceptual understanding of the structure of the integral itself, with the purpose of identifying instructional interventions that may help address these difficulties. These difficulties affect students' ability to apply integration methods correctly. The study was conducted with first-year students at the University of Shkodra "Luigj Gurakuqi" enrolled in the Bachelor program in Informatics, focusing on the transition from procedural methods of integration learned at the pre-university level toward more advanced reasoning grounded in structural understanding. The analysis revealed a tendency among students to apply familiar integration methods without adequately evaluating their suitability for the given problem. The findings indicate that these difficulties are mainly related to misconceptions regarding the structure of integrals and to difficulties in decision-making during the selection of an appropriate method. The study emphasizes the importance of engaging students in the comparison of alternative solution strategies and in the integration of diagnostic tasks in order to systematically address these deficiencies.

Keywords: *Integral calculus; students' errors; method selection; diagnostic assessment; mathematical understanding*

1. Introduction

The transition from secondary to university education represents a major challenge, first in terms of learning approaches and secondly in relation to the academic requirements that demand a higher level of abstraction in scientific subjects. Students often face difficulties adapting to new teaching approaches, the large volume of course material, and the increased emphasis on analytical and independent thinking. Mathematical Analysis constitutes one of the greatest challenges for first-year students enrolled in study programs with a mathematical component. These difficulties are also evident in the understanding and application of integration methods [1], [2].

A fundamental issue that has remained relatively underexplored is that students' difficulties do not lie solely in the technical execution of integration procedures. Many students are able to correctly apply familiar methods when these are presented explicitly, yet they encounter difficulties when they must independently decide which method should be used and why. This moment of decision-making, which precedes every solution process, constitutes the gap that the present study aims to investigate.

First-year students enrolled in the Bachelor program in Informatics study Mathematical Analysis as a compulsory subject. They generally come from a pre-university educational background oriented mainly toward algorithms and familiar exercise types, an approach that tends to favor procedural rather than structural reasoning.

Orton (1983) documented that students tend to treat integration as a sequence of mechanical steps without connecting procedures to conceptual understanding [1]. Mahir (2009) confirmed that procedural performance and conceptual understanding constitute two distinct dimensions [2]. Radatz (1979) showed that mathematical errors are systematic symptoms of the way students construct their understanding [3]. Nursyahidah and Albab (2017) linked difficulties in mastering integration to limitations in critical thinking skills [4].

This study contributes empirical evidence from the Albanian context on error patterns in the choice of integration method. The main theoretical contribution lies in the identification of a recurring pattern, here

termed premature procedural activation: the early triggering of a familiar method without prior analysis of the problem structure, identified as the dominant source of students' errors (defined more fully in Section 5.1). The study is guided by three research questions:
RQ1: How do first-year students identify the structure of the integral when choosing a method?
RQ2: What types of errors characterize method selection and what are their structural and conceptual sources?
RQ3: What metacognitive patterns emerge in students' decision-making during the integration process?

2. Theoretical Framework

2.1 Procedural and Conceptual Understanding

Hiebert and Lefevre (1986) proposed a foundational distinction between procedural understanding the capacity to execute learned algorithmic steps correctly and conceptual understanding, conceived as an interconnected network of ideas that confers meaning upon those steps [5]. In the context of integral calculus, the absence of conceptual grounding produces a characteristic fragility: students perform adequately in familiar problem types, yet encounter difficulties as soon as the structural configuration of the integral changes, even marginally.

2.2 Process-Object Duality

Sfard (1991) advanced the theory of process-object duality, according to which mathematical concepts may be apprehended either as processes or as objects [6]. Structural, object-based understanding is precisely what enables type recognition and, consequently, method selection. According to Tall (1991), many students entering university continue to rely mainly on operational forms of reasoning and experience difficulties in developing a more structural understanding of mathematical concepts [7].

2.3 Classification of Errors

Radatz (1979) classified mathematical errors as systematic symptoms of underlying misconceptions, identifying three principal categories: errors arising from misinterpretation of symbolic notation, errors from the context-independent application of algorithms, and errors attributable to gaps in conceptual knowledge [3]. Orton (1983) further distinguished structural errors rooted in a failure to recognise the integral's underlying form from executive errors, which emerge during the execution of a correctly identified method [1]. Broader frameworks in the literature [9] extend this classification to encompass the distinction between systematic errors, which reflect conceptual deficits, and random errors, produced by carelessness or situational factors. Some of these analyses also draw on cognitive psychology to illuminate the role of mental processes in the emergence and resolution of such difficulties.

2.4 Metacognition and Decision-Making

Schoenfeld (1985) documented that lower-achieving students tend to persist along unproductive solution paths without monitoring their progress, whereas expert problem-solvers flexibly revise their approach in response to emerging evidence [8]. Related research [10] underscores the contribution of formative self-assessment to the development of metacognitive regulation, enabling students to monitor and adjust their mathematical reasoning more effectively. From this perspective, choosing an integration method is not only a technical issue. Students must also evaluate whether the chosen strategy is appropriate and whether it is leading toward a valid solution

3. Methodology

3.1 Research Design

The study adopted a qualitative diagnostic design, oriented towards the analysis of structural reasoning and decision-making patterns. The diagnostic approach enables the exposure of mental processes, not just outcomes, and provides a direct basis for instructional interventions.

3.2 Participants and Context

The study was conducted with $n = 35$ first-year students, enrolled in the Mathematical Analysis course in the Bachelor's program in Informatics of the University of Shkodra "Luigj Gurakuqi" (academic year 2025–2026). Of these, 29 students submitted tests with at least partial answers, while 6 students did not complete any section, classified as level L0 (structural disengagement). The test was administered during class, without time pressure and without impact on students' grades. Participation was voluntary and anonymous.

3.3 Instrument

The diagnostic test "Integration Methods" was developed specifically for this study (100 points, open-ended, eight sections, 22 problems). The five integration methods are clearly labeled: M1 Direct, M2 Substitution, M3 By Parts, M4 Manipulation, M5 Standard. For each exercise, the student is required to: (a) identify the structure of the integral, (b) choose the appropriate method, and (c) justify the choice in a structural manner.

The tasks were developed by the authors on the basis of their teaching experience with this student population and of the error patterns reported in the literature reviewed in Section 2, in particular the procedural-conceptual distinction discussed by Hiebert and Lefevre (1986) [5] and the surface-based problem recognition documented by Mahir (2009) [2]. Several integrals were deliberately paired (e.g., 2a/2b, 4/9, 5/7) so that superficially similar items required, or did not require, the same method, in order to separate structural recognition from procedural execution. The diagnostic purpose attributed to each item, summarized in Table 1, was agreed upon jointly by the two authors prior to data collection. The instrument was not submitted to a separate pilot administration before the study; this is noted as a limitation in Section 7.

Section I (Structural Analysis) contains nine exercises selected to test structural differences, particularly the pairs 2a/2b, 4/9, and 5/7.

Section II (Decision Making) explores the initial method and structural indicators.

Section III (Abstract Structure) tests the transfer of reasoning to the forms $\int \frac{f'(x)}{f(x)} dx$, $\int f(x)\, dx$ and $\int f'(x) e^{f(x)} dx$.

Section IV (Error Analysis) requires critical explanation of the erroneous rule $\int f(x) \cdot g(x) d\, x \neq \int f(x) dx \cdot \int g(x)\, dx$.

Sections V–VIII collect metacognitive data and explore students' heuristics in choosing a method.

Taken together, the eight sections were designed to address four complementary aspects of integration competence. Structural recognition is addressed mainly in Sections I and III, where contrasting and abstract integrand forms require the underlying structure to be identified before any procedure is applied. Method selection is addressed in Section II, where students report and justify their initial choice of method. Procedural execution is addressed through the follow-up items in Sections I, II, and IV, which ask whether the chosen method was carried out successfully and whether it was revised during the solution process. Metacognitive control is addressed in Sections V–VIII, which ask students to reflect on the point at which they reconsidered an unproductive method and on the heuristics guiding their initial decisions.

Table 1. Exercises of Section I Structural Analysis

No.	Integral	Diagnostic Purpose
1	$\int xe^x\, dx$	Intended to assess recognition and application of integration by parts in a product structure involving algebraic and exponential functions (M3).
2a	$\int \frac{2x}{x^2+1}\, dx$	Intended to assess recognition of the logarithmic derivative structure $\frac{f'(x)}{f(x)}$, leading to logarithmic integration (M2).

No.	Integral	Diagnostic Purpose
2b	$\int \frac{x}{x^2+1}\,dx$	Designed to assess students' ability to adapt the logarithmic derivative structure when the exact derivative factor is not explicitly present (M2).
3	$\int \ln x\,dx$	Intended to assess recognition of implicit reformulation as 1·ln x, requiring integration by parts (M3).
4	$\int \frac{x^2}{x^2+1}\,dx$	Requires prior algebraic restructuring before integration can proceed (M4).
5	$\int \frac{x}{x^2-1}\,dx$	Designed to examine premature transfer of the $\frac{f'(x)}{f(x)}$ structure without sufficient structural verification (M2/M4).
6	$\int \frac{\sin x}{1+\cos x}\,dx$	Intended to assess transfer of the logarithmic derivative structure to a trigonometric context (M2).
7	$\int \frac{2x}{x^2-1}\,dx$	Intended to assess recognition of the logarithmic integration structure in a structurally similar but non-identical algebraic context (M2).
8	$\int \frac{1}{\sqrt{1-x^2}}\,dx$	Intended to assess recognition and retrieval of a standard inverse trigonometric integral form (M5).
9	$\int \frac{x^2+1}{x^2-1}\,dx$	Requires algebraic decomposition prior to the application of standard integration techniques (M4 + M5).

3.4 Coding System

Each response was coded according to four dimensions: (S) identified structure; (M) chosen method; (E) type of error: E0 = no error, E1 = weak reasoning, E2 = unclear criterion, E3 = wrong method, E4 = deep conceptual error, E5 = missing; (K) cognitive level (K1–K4). Based on the coding profiles, students were classified into six cognitive levels (L0–L5).
Coding was carried out independently by two coders for every completed item, applying the four-dimension scheme described above to the identified structure (S), the chosen method (M), the error type (E), and the cognitive level (K). The method labels (M1–M5) were given directly by the test format, while the error categories (E0–E5) and the cognitive-level descriptors underlying the L0–L5 classification reported in Table 2 were developed inductively, through an initial joint reading of a subset of responses, and were then applied systematically to the full dataset. After coding independently, the two coders compared their codes item by item and discussed any case of disagreement with reference to the original response and to the working definition of each category, until a shared code was agreed upon. All disagreements were resolved in this way, through discussion and consensus; given the relatively small number of double-coded responses, a quantitative inter-rater agreement coefficient was not calculated for this study.

3.5 Data Analysis

The data were analyzed at three complementary levels: (1) analysis of error frequencies by sections and exercises; (2) categorization of reasoning at three levels: surface, procedural, and structural; (3) analysis of metacognitive models. These three levels of analysis drew on the coding scheme and the coder-validation procedure described in Section 3.4.

4. Results

4.1 Distribution of Students by Cognitive Level

Analysis of the 35 diagnostic tests identified six distinct cognitive profiles (Table 2). The L0 and L3 groups each represented 28.6% of the sample, together comprising 57.2% of the participants. The L4

and L5 levels represented only 14.3%, indicating that full functional competence in the structure–method link was rare. Only one student (2.9%) demonstrated a stable structure–method link (L5).

Table 2. Distribution of students by cognitive level ($n = 35$)

Level	Student Profile	n	%	Dominant Error Pattern
L0	Pre-structural / Non-engagement	10	28.6%	E5 (absence of response)
L1	Formula recall / Low structural activation	5	14.3%	E5 + E3
L2	Surface-level recognition / Decoupled reasoning	5	14.3%	E3 + E1
L3	Overgeneralization / Method fixation	10	28.6%	E3
L4	Partially functional / Structurally conflicted	4	11.4%	E2 + E1
L5	Selectively functional structural reasoning	1	2.9%	E2 (selective)
	Total	**35**	**100%**	

4.2 Structural Errors: Not Knowing the Structure of the Integral

The dominant error category was structural: students activated a method before analyzing the structure of the integral. The contrasting pair 2a/2b, $\int \frac{2x}{x^2+1}\,dx$ and $\int \frac{x}{x^2+1}\,dx$, showed that (19 out of 29) responding students applied the same procedure to both integrals, without identifying that $\int \frac{x}{x^2+1}\,dx$ requires prior adjustment. These results suggest that structure recognition is based on surface features, not deep analysis, in line with Mahir's (2009) characterization [2].

Exercise 4, $\int \frac{x^2}{x^2+1}\,dx$, confirmed this pattern. Most participants attempted the substitution without verifying whether x^2 is a derivative of $x^2 + 1$. Only students at levels L4–L5 performed the preliminary manipulation $\frac{x^2}{x^2+1} = 1 - \frac{1}{x^2+1}$. Section III showed that the transfer to the abstract form $\frac{f'(x)}{f(x)}$ did not occur spontaneously: most students left these exercises unanswered.

4.3 Procedural Errors: Incorrect Implementation after Correct Choice

A second category of errors was identified in students who chose the correct method but made errors during execution. Procedural errors appeared mainly in exercises requiring double application of integration by parts ($\int x^2 e^x\,dx$) and in preliminary algebraic reformulation. According to Radatz (1979), these constitute execution errors, distinct from structural errors [3].

Exercise 17 showed that most students knew that the statement $\int f(x)g(x)\,dx = \int f(x)\,dx \cdot \int g(x)\,dx$ is false, but they failed to justify why, a phenomenon consistent with Hiebert and Lefevre (1986) [5].

4.4 Metacognitive Failures: Failure to Monitor the Process

Most students did not change their method during the process, or only changed it when they were completely stuck. Only a small percentage reported actively monitoring their progress, a finding consistent with Schoenfeld (1985) [8]. From the reflection section, the first step most reported was "try substitution" or "check if it is direct," not "analyze structure." This confirms that students' spontaneous approach is primarily procedural, not structural.

Table 3. Main error patterns by category and theoretical basis

Exercises	Observed Error	Category	Theoretical Basis
2a vs 2b	Identical procedures applied to structurally distinct integrals	Structural	Werner Radatz (1979)
4	Substitution attempted without prior algebraic restructuring	Structural	Anthony Orton (1983)
9	Direct substitution attempted without the required algebraic reformulation	Structural	Anna Sfard (1991)
10–14	No change of method observed during the solution process	Metacognitive	Alan Schoenfeld (1985)
10–14	High confidence reported alongside incorrect solutions	Metacognitive	Nizam Mahir (2009)
17	Inability to justify why $\int f(x)g(x)\,dx \neq \int f(x)\,dx \cdot \int g(x)\,dx$	Procedural	Werner Radatz (1979)
18	Failure to verify structural conditions prior to method selection	Structural	Anthony Orton (1983)

5. Discussion

5.1 Premature Procedural Activation Without Structural Analysis

The central finding of this study, that students activate a method before analyzing the structure of the integral, constitutes the main theoretical contribution. This phenomenon, which we term premature procedural activation, explains most structural errors and can be interpreted through Sfard's (1991) process-object framework: students operate with an operational, not a structural, conception of the integral [6]. The transition that Tall (1991) identifies as essential, from operational to structural thinking, had not yet been realized for most of the sample [7].

We define premature procedural activation as the early triggering of a familiar integration procedure, most often substitution or integration by parts, before the structure of the integrand has been adequately analyzed. The concept is related to, but distinct from, two profiles already identified in Table 2. It differs from surface-level recognition (the L2 profile), in which a method is chosen on the basis of superficial visual cues, such as the presence of a quotient or of the symbol "ln", rather than of a verified structural property. It also differs from method fixation (the L3 profile), which describes the persistence of a method once chosen, even when subsequent steps indicate that it is unproductive. Premature procedural activation can be understood as the initiating mechanism behind both profiles: surface-level recognition concerns what students attend to instead of structure at the moment of selection, while method fixation concerns what happens afterward, once an unverified method has already been activated and is not reconsidered.

The concept should also be distinguished from a general overreliance on procedural knowledge. Most students who showed premature procedural activation were, in principle, able to apply a method correctly once it had been selected, whether the selection itself was correct or not; the errors described in Section 4.3 were procedural rather than structural in nature. In terms of the coding scheme presented in Section 3.4, premature procedural activation is most directly reflected in responses coded E2 (unclear criterion) or E3 (wrong method), where a method (M) could be identified despite an absent, incomplete, or post-hoc structural justification (S); the coding scheme used in this study does not include a separate code dedicated specifically to this phenomenon.

The pedagogical implication is clear: it is not enough to learn the application of a method; it is essential to develop the ability to recognize the structure that requires it. In this sense, the sequencing of teaching must be reoriented, placing structural analysis before procedures.

5.2 Consistency with Existing Literature

The results are in full agreement with Mahir (2009), who documented that students with a dominant procedural understanding identify the type of problem based on its appearance [2]. The pair 2a/2b confirms this mechanism clearly. The metacognitive failure documented by Schoenfeld (1985) is reflected in students' insistence on using unproductive methods [8]. Overall, these findings suggest that the fundamental difficulty in method selection is not technical, but epistemological.

6. Implications for Teaching

The following implications are derived directly from the diagnostic findings reported above. Their pedagogical effectiveness has not been tested empirically within this study; they are proposed here as directions for classroom practice and as hypotheses for future research.
First, the systematic use of contrasting pairs (e.g., 2a/2b), characterized by superficial similarities and structural differences, may support the development of structural recognition, provided that such exposure is deliberate and ongoing rather than occasional.
Second, requiring a written justification as a mandatory step, "Why did you choose this method?", is intended to encourage structural engagement before selection, and could be integrated as a routine component of classroom exercises.
Third, teaching should position structural analysis as an explicit phase of the solution. The question "What do I notice in this integral?" should be the first step, clearly articulated, not assumed.
Fourth, treating typical errors (e.g., $\int f(x)g(x)\,dx \neq \int f(x)\,dx \cdot \int g(x)\,dx$) as case studies may support the transition from memorization to conceptual understanding.

7. Study Limitations

Despite the diagnostic value of the findings, this study should be interpreted within several limitations. First, the research was conducted within a single higher education institution and involved a relatively small number of students who agreed to participate in the study. The study was motivated by recurring difficulties observed among first-year Bachelor students in Informatics when selecting appropriate integration methods. The aim was to focus directly on students' difficulties rather than to follow a traditional, linear approach to teaching.
Moreover, the diagnostic instrument itself was not submitted to a separate pilot administration before the study; its tasks were developed directly from the authors' teaching experience and from the literature reviewed in Section 2, rather than from a preliminary empirical check of item difficulty. This is consistent with the diagnostic, exploratory purpose of the study, but it also means that the psychometric properties of individual items were not established prior to data collection.
In addition, since students were informed that the test would not be graded, not all participants engaged with the same level of seriousness and commitment throughout the diagnostic process. Although several students voluntarily agreed to participate, some of them left sections incomplete or provided only partial responses.
Furthermore, the present study represents primarily a diagnostic investigation of students' difficulties and proposes a framework for pedagogical intervention. However, the effectiveness of these interventions was not empirically tested within the scope of this research and therefore remains open for future studies and broader comparative investigations. Future work might also explore whether targeted structural instruction, even in brief form, leads to measurable shifts in students' method-selection strategies.

8. Conclusions and Recommendations

This study provides empirical evidence that the dominant difficulty faced by first-year students in solving integrals is not related to the technical execution of integration techniques, but rather to the structural analysis of the integral and the decision-making process involved in selecting an appropriate method of solution. The three categories of errors, structural, procedural, and metacognitive, reflect distinct dimensions of the same fundamental gap: the lack of transition from operational to structural understanding.
The diagnostic instrument used in this study provides not only a research tool, but also a pedagogical tool. The study has important limitations, since it was conducted within a single institution and the sample size is also relatively modest.

Future research should test the proposed interventions through comparative designs and expand the sample to other university contexts. A practical starting point would be to require students, as a regular habit, to write one sentence before beginning any solution. This sentence should state what they notice about the structure of the integral and why that observation matters for choosing a method.

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Cultivating Empathy through Literature and Creative Writing

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Abstract

The aim of this initiative, which has been planned and implemented throughout the 2025-2026 school year in the 2nd grade of a greek private high school in Athens, is to cultivate empathy and understanding of the "Other" through Literature and Creative Writing. More specifically, this is pursued through organized and targeted activities grounded in contemporary theories of empathy in literary studies. According to these theories, empathy is not understood merely as an emotional response of students to literary texts, but also as a complex cognitive-emotional skill that develops through engagement with literary works. Through this process, students gradually become aware that differences among people are shaped by various factors and therefore should be approached with respect and understanding. Contemporary research suggests that while today's youth demonstrate proficient cognitive empathy – the intellectual understanding of others' emotional states– they often encounter difficulties regarding affective empathy, or the capacity to viscerally experience another's emotions. This deficit, partly attributed to digital mediation and its inherent interpersonal distance, hinders effective emotional self-regulation. Consequently, fostering the affective dimension of empathy is of paramount importance. Adolescents require "safe environments" to practice empathic engagement without perceived threats to their own identity. Literature can serve as such a sanctuary, offering a protected space for emotional exploration. Correspondingly, creative writing can function as a secure pedagogical tool, facilitating a deeper understanding of the "Other" while simultaneously promoting self-reflection and self-awareness. Starting from selected modern greek literary texts (prose or poetry), students come into contact with diverse human situations and different types of characters (both deviant and non-deviant, misunderstood and not misunderstood). They approach these heroes and heroines and attempt to interpret their behavior with an attitude of understanding toward human nature, without arrogance or condemnation. They reflect on questions such as: What led the hero or heroine to react in this way? How is this behavior perceived by others who do not know the circumstances? Indicative Creative Writing activities with a psycho-emotional orientation, aiming to strengthen empathy (narrative, poetic, and critical empathy) and sensitivity, include: the Emotion Diary, the "Cardiogram" of the character, the character's internal monologue and others.

Keywords: *Empathy, Creative Writing, Literature*

1. Introduction

The aim of this initiative, designed and implemented throughout the 2025-2026 school year in the second grade of a greek private high school in Athens, is to cultivate empathy and understanding of the "Other" through Literature and Creative Writing. More specifically, this objective is pursued through structured and carefully designed activities informed by contemporary theories of empathy in literary studies. According to these approaches, empathy is understood not simply as students' emotional response to literary texts, but as a complex cognitive and emotional skill that develops through engagement with literature. Through this process, students gradually come to realize that differences among people are shaped by multiple factors and should therefore be approached with respect, sensitivity, and understanding.

Contemporary research indicates that, although today's adolescents often display strong cognitive empathy –that is, the intellectual ability to recognize and understand the emotional states of others– they frequently struggle with affective empathy, namely the ability to emotionally and viscerally experience another person's feelings. This limitation, partly associated with digital mediation and the interpersonal distance it creates, may hinder the development of effective emotional self-regulation. For this reason, strengthening the affective dimension of empathy is considered particularly important. Adolescents need "safe spaces" in which to practice empathic engagement without feeling that their own identity is threatened. Literature can function as such a refuge, offering a protected environment

for emotional exploration and reflection. Likewise, creative writing can serve as a secure pedagogical tool that encourages a deeper understanding of the "Other", while at the same time fostering self-awareness and introspection.
Through selected modern greek literary texts, both prose and poetry, students encounter a wide range of human experiences and diverse character types –including individuals who are marginalized or socially accepted, misunderstood or fully understood.

2. Empathy in Literary Education

The integration of Empathy into literary education is promoted by the emerging field of empathy studies in literature, which emphasizes the close connection between reading and the empathic process. This process does not presuppose the physical presence of another person, as the reader may develop an emotional connection with the "Other" through fictional characters.
This field argues that, at an educational level, empathy can be cultivated through students' active engagement with literature (reading, writing, analysis) by means of a specific methodology focused on "perspective-taking," encouraging students to identify with or approach characters while taking into account their sociocultural background. Creative Writing may play a central role in this approach, as it mobilizes imagination and thought, allowing students to experience the inner world of literary heroes. This experience appears to promote emotional maturity and strengthen respect and tolerance in everyday social life (Hoffman, 2000).

2.1 From Sympathy to Empathy

Historically, the concept of "sympathy" (fellow-feeling) has been fundamental in western thought regarding the experience of the self in relation to the other. Etymologically, it derives from the ancient Greek word "sympatheia" (syn + pathos), meaning participation in another person's suffering (Hammond & Kim, 2014: 2). This form of emotional engagement became inextricably linked with art (Pinotti & Salgaro, 2019: 141). Contemporary approaches define empathy as the innate human ability to participate in, understand, and respond with care to the emotions of fellow human beings (Hammond & Kim, 2014). Despite interdisciplinary divergences, there is broad agreement that empathy possesses both cognitive and emotional dimensions (Decety & Jackson, 2006: 54):
• Cognitive dimension (perspective-taking): The conscious understanding of another person's emotions.
• Emotional dimension: The indirect experience of another person's emotion, which often develops into "empathic concern" (Van der Graaff et al, 2013).

2.2 The Pedagogy of Empathy

Within the Pedagogy of Empathy, empathy is regarded as a pillar of social development and emotional intelligence (Batson, 2009· Mayer & Salovery, 1993). According to Jamieson (2015), empathy lies at the core of quality teaching. Practices such as collaborative learning, role-playing, and engagement with the arts enhance this ability (Feshbach & Feshbach, 2009). During adolescence, neurological development and the shift toward peer relationships make this stage of life ideal for the cultivation of empathy (Hoffman, 2000).
Contemporary studies on empathy, recognizing its conceptual multiplicity, focus on the ways in which the processes of "thinking with" (cognitive) and "feeling with" (emotional) are activated within the literary framework (Hammond & Kim, 2014: 1).
Literary engagement enables a profound connection with the "Other" on both cognitive and emotional levels (perspective-taking) (Leake, 2016; Coles, 1989; Hoffman, 2000; Mar et al., 2006). Systematic writing through shifts in perspective cultivates enduring empathic habits (Leake, 2016).
Through literature, students experiment with unfamiliar cultures and situations within a safe environment, thereby reducing social prejudices (Jamieson, 2015; Shuman, 2006; Mar, Oatley & Peterson, 2009). However, this ability often encounters social prejudices toward different population groups (Cameron et al, 2019; Kiser, 2017).
According to Keen (2013), narrative empathy concerns the sharing of emotions through stories in every form (literature, theatre, cinema). Keen (2006: 214-224) emphasizes that narrative techniques (such as narrator type and focalization) interact with the reader's temperament. She distinguishes empathy into three categories:

1. Bounded empathy: directed toward one's own group.
2. Ambassadorial empathy: directed toward selected groups.

3. Broadcast empathy: characterized by a universal human orientation.

Critical empathy incorporates critical awareness, recognizing that connection with the "Other" is complicated by sociohistorical factors that hinder equality (Leake, 2016). It is based on the assumption that the common human need for self-actualization encounters different cultural and social conditions (Lu, 1999: 173).
The theoretical approach of "feeling into" (Einfühlung) constitutes the cornerstone for understanding poetic experience and reader response to this day. Empathic reading contributes precisely to this process, allowing readers to broaden their horizons and the parameters of their reading act. Lou Agosta refers to the "hermeneutic circle" of the empathic process. This is a process consisting of four phases: a) empathic receptivity of the "open subject" to the various representations of emotional expressions and the lived experience, real or imaginary, of the other; b) empathic understanding; c) empathic interpretation, "as if you were the other, in the other's place"; and d) empathic responsiveness, consisting of exemplary speech acts that ensure optimal communication (Agosta: 1984; 2010: 46).
Within the spectrum of reader-response theories, David Bleich's "subjective criticism" occupies a prominent position, emphasizing the reader's emotional participation (Beach, 1993: 53). In his works *Readings and Feelings* (1975) and *Subjective Criticism* (1978), Bleich proposes the "subjective re-creation" of the text. For Bleich, reading is not contact with a physical object (words on paper), but a perceptual act in which sensory experiences are transformed into consciousness through individual meaning-making processes (Bleich, 1978: 97).

2.3 Criteria for Text Selection

The pedagogy of empathy presupposes the selection of texts that facilitate connection with characters while at the same time maintaining the distinction between self and hero (Coplan, 2004:144). Reading immersion is crucial, as lack of engagement may reduce levels of empathy (Bal & Veltkamp, 2013). Enjoyment, as an intrinsic motivation, is achieved through thematic relevance to adolescent life (Pitcher et al., 2007). Texts addressing moral dilemmas are also recommended (Edgar, 2020: 68-69), so that literature may function as a tool of social criticism. Selection must always be aligned with the cognitive and emotional level of the students (Junker & Jacquemin, 2017; Gallagher, 2009).

2.4 Typologies of the Empathic Reader's Emotions

Through the emotional stimulation of readers, the path toward empathic reading is opened (Keen, 2006). By responding empathically, the reader of a text (prose or poetry) shares the emotions of the characters (Miall & Kuiken, 1995).
The reader's emotional engagement during literary reading differs from real social interactions, as it is primarily based on imagination. It may be distinguished into four fundamental categories (Miall & Kuiken, 2002; Sikora, Kuiken & Miall, 2004):

1. Evaluative feelings: These concern the overall assessment of the text as a whole (e.g., pleasure, satisfaction).
2. Aesthetic feelings: These arise from the formal structure of the work (stylistic devices, metaphors, irony, rhythmic organization) and enhance reading interest through the aesthetic enjoyment of form.
3. Narrative feelings: These focus on specific aspects of fiction, such as empathy toward acting characters.
4. Self-modifying feelings: These reconstruct the reader's self-image, producing symbolic representations capable of transforming personality itself (Miall & Kuiken, 2002; Sikora, Kuiken & Miall, 2004).

2.5 Creative Writing in the Teaching of Empathy

Creative Writing constitutes a quintessentially experiential method for cultivating empathy, since it requires students to adopt the perspective of literary characters (Jamieson, 2015: 230). Through the production of imitative or reflective texts and the subsequent critical discussion, students are gradually led toward the development of critical empathy (Junker & Jacquemin, 2017: 80).

3. Description of the Teaching Proposal

The following teaching proposal was implemented with twenty-seven mixed-ability students in the Modern Greek Literature course of the second grade of a General Upper Secondary School in a private school in Athens. It was designed by two teachers between whom a mentoring relationship exists. The teachers implemented the following proposal in two classes. The first class consisted of 9 girls and 5 boys, while the second consisted of 11 girls and 2 boys.
The intervention, which utilized the activation of empathy during the educational process, lasted throughout the entire 2025-2026 school year. During this period, the teachers identified suitable texts (prose and poetry), selected the most appropriate creative writing exercises, and prepared the students for participation in a related conference held in Athens.
Regarding the selection of texts, it was considered necessary that they should raise concerns and questions through whose exploration students would cultivate their empathic ability. These questions were the following:
• What does the hero/heroine feel?
• Can I put myself in his/her place? Can I empathize with him/her?
• Do I identify with him/her?
• Do I understand him/her?
• What led the hero/heroine to react in this way?
• How is this behavior perceived by others who do not know the background?
• How easy is it for each of us to arrive at hasty and superficial conclusions about another person?
• How easy is it to assign a label or characterization to another person? How important (but also how difficult at times) is it to approach the diversity and uniqueness of human nature with understanding?
Regarding prose, texts were selected from the school textbook *Texts of Modern Greek Literature, Grade B of Lyceum*: “Pararlama” by Demosthenes Voutyras, “The Secret Poppy” by Stratis Myrivilis (excerpt from the novel *Life in the Tomb*), “The Seal’s Lament” by Alexandros Papadiamantis, and “Alexis Zorbas” by Nikos Kazantzakis (excerpt from *The Life and Times of Alexis Zorbas*). As for poetry, the teachers utilized the following works: “[We are something…]” by Kostas Karyotakis, “Marina of the Rocks” and “Maria Nefeli” by Odysseas Elytis, as well as a selection from the *Complete Works* of Kiki Dimoula.
Subsequently, the most suitable creative writing exercises for strengthening empathy and sensitivity were selected. These activities had a psycho-emotional orientation and focused on the creation of original student texts inspired by the texts presented to the students. Indicatively, these included the creation of a personal anthology, theatrical monologue/dialogue writing, dramatization, sketching, diary writing, and original poetic composition. These activities, however, will be presented in greater detail below.
The intervention concluded at the end of the school year with the distribution of a feedback questionnaire.

3.1 Empathic/Empathetic Reading

Starting with prose, in Demosthenes Voutyras’s work “Pararlama”, the students became acquainted with the marginalized and unstable character of the eponymous short story, who longs to become the center of attention by writing the incomprehensible slogan “Pararlama” and taking pleasure in provoking fear and terror. In order to bridge the distance between themselves and the character, the students were asked to answer a series of questions:
• What might drive a person to such behavior?
• How can isolation and exclusion disturb one’s inner balance?
• What kind of treatment might people in a state of weakness deserve?
In approaching the short story, the aim was not to psychoanalyze the character or investigate his pathology, but rather to understand his behavior and human vulnerability.
In the excerpt “The Secret Poppy,” from Stratis Myrivilis’s book *Life in the Tomb*, teachers introduced their class to the following questions:
• How might Sergeant Kostoulas feel?
• What might the war have done to his soul?
• What psychological defenses might he have employed in order to survive in the trench?
• Why does the encounter with the poppy provoke such an emotional overreaction?
• How can a person manage their emotions during a period of intense crisis such as war?
• Does he allow himself room to feel?

• Might he need to “silence” his emotions (fear, guilt, love, hope)?

Furthermore, we followed the journey of old Loukaina in Alexandros Papadiamantis’s short story “The Seal’s Lament”, alongside the tragic course of her little granddaughter, Akrivoula, who, enchanted by the melody of a carefree shepherd, was led to her death. Through discussion among the students, the following questions emerged:
• How might old Loukaina and Akrivoula’s mother have felt?
• What emotions arise in the reader?
• Can we empathize with old Loukaina?
• What would we have felt if we were the shepherd?

Moving on to the excerpt from Nikos Kazantzakis’s novel *The Life and Times of Alexis Zorbas*, an attempt was made to construct a psychological profile of the book’s protagonist. To this end, students focused on the following questions:
• What type of person is Alexis Zorbas?
• How might we interpret his psychology?
• Would you like to meet such a person?
• What might companionship with him offer, and how easy would it be?
• What experiences may have led the character to adopt this attitude toward life and this behavior?

The students’ empathic/empathetic engagement became even more intense through poetry. This empathic/empathetic journey began with Kostas Karyotakis’s poem “[We Are Something…]”, included in the second-grade school textbook. The teachers’ aim was for the recipients of the poem to approach the poetic subject by constructing its psychological profile and answering key questions in order to achieve this goal more effectively. These questions were the following:
• What might the poetic subject be feeling? Disappointment? Dissatisfaction? Resignation? Understanding?
• How does the speaker express these possible emotions? Why might they feel this way? Are these emotions understandable? Might they be excessive?
• Why might the speaker refer to poets and to themselves in this manner?
• Where might the speaker place themselves?

Subsequently, the poetry of Odysseas Elytis was explored, specifically the poem “Marina of the Rocks” and excerpts from the poetic collection “Maria Nefeli”. In the first poem, the emotional background was examined, and an attempt was made to answer the following questions:
• What does the poetic voice feel?
• What are the characteristics of “Marina of the Rocks” that may intensify the poetic voice’s desire to “conquer” her?
• How do we explain the behavior of each figure?
• Which verse attracted our attention? Why might this have happened?

While it became clear that in this poem only the male poetic voice is heard, addressing a rebellious female figure, in “Maria Nefeli” at least two poetic voices are heard: Maria Nefeli, a different kind of girl who struggles to fit into the world, and the “Respondent,” an entity that seems to embody adult thought, convention, limitation, and the “Other”. A voice that stands in opposition to Maria Nefeli. We attempted to define Maria Nefeli’s nature, explain her behavior, and explore any similarities between ourselves and her.
After completing the empathic/empathetic approach to the poems of Odysseas Elytis, and in collaboration with the schools’ drama instructor, an attempt was made to create a theatrical representation of the two poems, through which the students approached the emotions arising from experiential engagement with Elytis poetry. Through this activity, which was based on an original text by the drama instructor, “Marina of the Rocks” was connected with “Maria Nefeli”, constituting a first step toward a more creative perspective through which students could appreciate poetry.
Similar were the empathic/empathetic reading approaches to the poetic texts of K. Dimoula and K. Karyotakis.

3.2 Empathic/Empathetic Creative Writing

The prose and poetic texts already mentioned served as stimuli for the externalization of students' emotions and thoughts regarding elements of the plot and the heroes/heroines that came alive in their minds during empathic/empathetic reading. Among the creative writing activities utilized were the following: an "emotion cardiogram" (an attempt to record the emotions of the hero/heroine), the hero's monologue (a written transformation of "feeling into" through the question "What might the hero/heroine be thinking?"), rewriting the story or part of the story from the student-author's chosen perspective through the question "What would happen if…?" with emphasis on emotion, and the written transformation of "perspective-taking" through the questions "If it were me? How would I feel? What would I do?"

The poem "[We are something…]" by Kostas Karyotakis served as the poetic stimulus for the creation of original written compositions by the students. This activity allowed students to express what they feel as adolescents, pressured and anxious second-grade Lyceum students, or as observers of a world changing rapidly, abruptly, and uncontrollably.

One way of understanding the distinctive surrealist writing of Odysseas Elytis was the assignment of text production through the technique of automatic writing. This is a written production technique in which the filters of logic are bypassed and the speed of thought, the leaps of reasoning, and the faithful succession of emotions are recorded through writing. Although at first glance disconnected from empathy, this activity contributed to liberating students from the constraints of written discourse and the meticulous rules imposed by structured writing within the context of upper secondary education.

The poetry of Kiki Dimoula played a leading role in the empathic activation of students. Initially, students were asked to write a poetic "advertisement" inspired by Dimoula's poem of the same title. Through this activity, they themselves requested something personal they desired and expressed what they could offer in return.

The next creative writing exercise revolved around the poem "The Periphrastic Stone" by the same poet. Students practiced creating a theatrical dialogue or monologue in which they depicted the conversation between the poetic subject and the recipient of the poem, or alternatively the recipient's response to what had been heard through the poem.

In a subsequent teaching session, students came into contact with Kiki Dimoula's poem "Dust" and created their own diaries in which they recorded their impressions from encountering these housewives, so familiar to all of us. Through diary-based creative writing, students practiced perspective-taking, self-empathy, self-understanding, and the expressive representation of a symbolic catharsis.

4. Conclusions – Suggestions

For the evaluation of the intervention, the following tools were utilized:

a. observation of the participating students during the creative exercises assigned each time by the two responsible teachers,

b. the feedback questionnaire, and

c. feedback from students who functioned as a focus group (oral feedback was requested from students of different academic performance levels and varying degrees of classroom participation).

The following findings emerged:

Not all students are familiar with such teaching models. Literature as a subject is often perceived negatively by learners, and there is always the possibility that certain stereotypical attitudes may be reinforced among some students. These attitudes may stem either from the tendency to criticize the portrayal of a character's weaknesses or from the belief that Literature itself constitutes a secondary and less important field of study.

The active involvement of the teacher is essential in order to safeguard students and create a safe environment in which they can express themselves openly and without inhibition. The teacher must remain vigilant in maintaining classroom balance and in eliminating any tendencies toward judgment, belittlement, or arrogance among participants.

The respect that the teacher expects from students must also be demonstrated by the teacher during the presentation of creative assignments to the whole class. The purpose of the intervention is to encourage students' self-expression and cultivate empathy, not to showcase the teachers themselves. Students should neither feel exposed nor pressured into making statements they do not wish to make.

Preparing these workshop-style creative writing lessons requires considerable time on the part of the teacher, both for selecting appropriate texts –texts that raise meaningful questions capable of activating empathy and/or texts preferred by the students themselves, with the ideal approach being a combination

of both. Moreover, the implementation of creative writing activities cannot realistically take place outside the school environment, both for reasons of authenticity and reliability of the students' work and because of the already demanding schedules students face. At the same time, teachers must also ensure that the prescribed curriculum is adequately covered.

Creative writing can bring students closer both to written expression and to the understanding of the "Other". However, for this to happen, educators themselves must also become more familiar with such alternative teaching approaches. A shift in mindset is therefore required among teachers, students, and parents alike if creative writing is to be meaningfully and systematically integrated into educational practice.

Students succeeded in putting themselves in the place of the "Other". They viewed the world from a different perspective and understood emotions they had not previously experienced. They recognized and named emotions: poetic stimuli functioned as opportunities for emotions to emerge, enabling students to recognize and express them in their own way. They practiced listening and acceptance: their emotional understanding was strengthened, while any critical tendencies they may previously have had were weakened. Through the reading of their creative works before the whole class, both the absence of competitiveness and the strengthening of interpersonal relationships became evident. Particularly characteristic was the image of students who felt hesitant while presenting their texts receiving encouragement from their classmates.

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Games and Media in Education

Overcoming GBL Teaching Barriers: The Preliminary Stages of a Teacher Action Research

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Abstract

Game-based learning (GBL) is a motivating and engaging approach to foster students' learning [21]. However, teachers complain that there are many social-organizational barriers to face when integrating games in didactics, which need to be overcome with training [12]. Hence, Ricerca-Formazione (Teacher Action-Research) [4], is chosen as the methodological pathway to foster meaningful research and professional development processes. A community of primary school teachers in the Lecco province in Italy asked to be trained to help them use games in their teaching practice. Throughout 5 Professional development sessions in 2024 and early 2025, teachers practiced instructional design, game analysis, gaming, game modding, and had group discussions for debriefing. Thereby, these teachers defined lack of colleagues' collaboration, due to their traditional teaching style, as the most common and challenging obstacle for game integration in their school contexts. To understand this issue's dynamics, 3 in-training teachers played a theatre game [5], which consisted in the staging of a discussion among colleagues who disagree on game use. The scene was then analysed together with other in-training teachers to look into the portrayed issue, considering different perspectives. Thus, they devised solutions to overcome these challenges and they staged them as well to have a sense of their potential. The second performance was also analysed to get a sense of the actual impact of the designed changes. The overall thematic analysis [9] of the transcribed scripts of the role-plays and of all the focus groups shows that colleagues' resistance toward game classroom use shouldn't be belittled but understood. In fact, teachers with a propensity for traditional didactics are often reluctant to game integration, because of their emotional and pedagogical insecurity. Therefore, teachers who want to promote GBL need to find an accommodating way to convince colleagues of the potential of game use, taking into account the issues all teachers bring forward. In conclusion, game-based teacher training strategies such as role-plays and theatre games allow for a better understanding of teachers' issues and how to address them, as they highlight relational and organizational complexities.

Keywords: *Professional Development, Game-based learning, Teacher Action-research, Theatre games, Analog games*

1. Introduction

Game-Based Learning (GBL) is a pedagogical approach that leverages the affordances of games to facilitate a learning experience which integrates gaming with other specific activities to attain defined learning outcomes [21]. At its core, GBL relies on the active and focused investment of effort in a game environment, encouraging students to learn via experience and direct participation, rather than through traditional methods. From a socio-constructivist perspective, games are viewed as socially situated systems where knowledge is not merely transferred, but is co-constructed through intersubjective and relational processes.

This approach identifies games as meaningful ways to foster learning in their Zone of Proximal Development [30], providing a safe Magic Circle [17], where the rules and structures of the game act as a scaffold for exploring outcomes beyond one's imagined current abilities. According to Boller and Kapp [7] a game is defined as an activity that consists of a goal and of rules that guide how that goal is achieved. Thus, players have to face a challenge which requires interactivity with other players or the game environment. Accordingly with the game mechanisms, the game feeds back information related to the physical state changes of the game. This feedback offers immediate cues regarding the players' performance and, so, it affects them cognitively and emotionally. Hence, games function as a nexus of practice, facilitating situated learning, since skill development is inextricably linked to social interaction and cultural context [23].

Lave and Wenger's theory of Community of Practice is the primary theory used in this study to frame the learning processes [18], as it is centred on situated learning and legitimate peripheral participation.

Thereby, it provides a robust framework for social knowledge acquisition for what concerns student learning and teacher professional development. However, critiques suggest that without specific intervention, this model can mirror what Freire defines "banking education", which prioritizes the community's status quo over individual agency [15][16]. Therefore, to avoid this risk, this study requires the integration of the Community of Practice Theory with some principles of Freire's Liberation Pedagogy. This implies that being in a community is to be seen as something that evolves into a liberatory praxis where learners are active subjects with agency to change the system they are in. This theoretical blending is possible because both frameworks share a common intellectual heritage connected to Marxist analytical perspectives [16], specifically those inherited from the works of Vygotsky [29]. This synthesis facilitates the creation of what can be defined as a Community of Thought [19], which shifts the focus from mere shared tasks to the critical reflection and understanding of intentions, underlying shared practices. This ensures reciprocity and dialogicity, empowering participants to intentionally transform both themselves and their social reality.

Having defined this blended framework, the issue that is hereby investigated is how teachers can integrate games into their didactics. Studies stress that for this to happen teachers need to develop a set of competencies and, especially, attitudes [23]. First and foremost, Game Literacy is required, because teachers need to understand games and need to know many games to choose from [7]. Moreover, teachers need to develop a Lusory Attitude [3][28], which means that they need to be imaginative, flexible, resourceful, resilient and reflective. Moreover, teachers need to develop a set of pedagogical, creative, technical and collaborative competencies [20]. One particularly relevant pedagogical skill, that is often lacking, because it implies a challenging task, is the aligning of game and learning goals [1]. At the same time, teachers need to adopt games as heuristic devices that foster students' co-construction, exploration, expression and sharing [25]. Thus, teachers need to design their instruction so that they get their students to inquire, communicate, co-construct knowledge and try different forms of expression that make sure the game's learning potential is brought out [14].

Mastering all these instructional design practices requires teacher training processes that are recursively situated and that guarantee that what is learnt can be contextualized in the teachers' school contexts [31]. This becomes necessary because teachers who try implementing GBL often face many different types of barriers. Therefore, GBL Professional Development (PD) needs to address these barriers, fostering teachers' understanding of how to overcome them. Moreover, to comprehend the potential practical issues that can be encountered, these PD experiences need to be hands-on and collaborative, by promoting gaming sessions, game analysis and game design alongside peer discussions [10]. Thus, these PD programmes can reinforce the potential value of games for learning, because also teachers learn by playing.

There are many different types of games that are used for GBL, both for student learning and teachers' PD. Digital games have undoubtedly become the most popular in the last 20 and more years [21], but there have been many studies looking into the use of analogue games for learning [1][23]. Among these analogue games, board games are most recurrently adopted, because they are effective for promoting the development of many cognitive, social and emotional skills. However, theatre games and role-playing games are also promoted, because they integrate narrative, collaboration, and character development into a comprehensive educational experience [5][22]. Role-playing games are used, especially for PD, because they help analyse and deal with multiple realistic workplace challenges in a compressed period [21]. More specifically, Boal's theatre games treat theatrical language as the most essential human language, that is meant to be accessible both for professional actors and "non-actors". to foster active problem solving [5]. Indeed, one of these forms of play, defined as Forum Theatre, consists in a theatrical game where a problem is staged in an unsolved form. The members in the audience, acting as "spect-actors", are invited to think of different solutions to suggest them or to stage them personally, together with the other actors, even taking the place of the protagonist, so as to enact the imagined solution. Hence, the stage functions as a rehearsal for real-life action, allowing participants to acquire knowledge and tactics to break cycles of oppression in reality, as it is advocated in Liberation Pedagogy and in the Theatre of the Oppressed [6][15].

However, it is important to remember that the great potential of these games is fostered carrying out in-between formal debriefing stages [13][22], as they allow learners to analyse and reflect on what might be latent in the game experience. Thus, they allow a transfer of skills from the "Magic Circle" of games and play to the real world.

2. Research Questions

- How can teachers involved in Professional Development overcome social and organizational barriers for Game-based Learning adoption?
- How can Theatre games allow teachers to rehearse and validate strategies to manage barriers within their school ecosystem?
- How does participating in a Ricerca-Formazione (Teacher Action Research) affect teachers' professional identity and GBL practices?

3. Methodology

Since this study adopts a Reflexive Thematic Analytical approach [9], it is necessary for myself as a researcher to clarify my background and perspective. I am a 41-year-old PhD student from the University of Milano Bicocca, carrying out research on the Professional Development of teachers who adopt GBL. I have worked for 10 years as a primary school teacher in Italy, specifically in the province of Lecco. I consider this relevant since the teachers belonging to the "Faro Didattico" community, I am doing research with, work in the same province. I also think it's important to state that I have been an active member of this and other teacher communities for the last 4 years, because of the value I give to teacher Professional Development within onsite communities. In addition, I am a man doing research quite exclusively with female teachers and I consider myself a game expert and enthusiast, which is not really typical of Italian teachers [2]. Moreover, I have adopted Game-based Learning in my teaching between 2019 and 2024, and my Master's dissertation in Primary School Education was on Game-based Learning and Game Design for primary school teaching.
This research has been conducted using a qualitative and transformative approach, which follows the Ricerca-Formazione (R-F) methodology [4]. R-F is a specific Italian research approach influenced by the international studies on Teacher Action Research [24]. This methodology posits that:

- teachers should choose to participate and be co-researchers, having well-defined and negotiated roles and goals;
- researchers and teachers should work together as a group according to their negotiated roles;
- the research needs to focus on the specificities of the contexts in which the teachers operate to define barriers and facilitating factors;
- teachers need to have a continuous discussion together with the researcher focused on didactic and school documentation that proves the actual changes happening in the school, in the teaching and in the learning;
- The research needs to have a transformative aim, specifically on how it changes students' learning, teachers' didactics and their school's culture. Thus, these processes need to be monitored ongoingly.

This R-F specifically involved a community of teachers from the Lecco province in Italy between 2024-2025. Within the context of this community, around 80 of these teachers participated in 2 preliminary Professional Development (PD) sessions to familiarize with GBL. Consequently, a restricted group of 8 of them agreed to carry out 3 further monitoring sessions to help them facilitate game integration in their didactics in their school contexts. This whole professional development initiative is then meant to proceed in 2025-26, but this contribution will only look into what happened within this PD teacher community in the first year their teachers trained on GBL.
During these training and monitoring sessions the teachers have played board games, outdoor games, role-playing games and videogames. Moreover, they modified board games [27] to make them align more with their learning goals and to make them more inclusive, according to the Universal Design for Learning principles [11].
In-between the 3 monitoring sessions the teachers were asked to try and adopt GBL in their classes and to document their experience, so as to discuss about it with the other community teachers through some focus groups. This allowed for the integration of co-constructed operative strategies to deal with their educational barriers [8]. Indeed, teachers pointed out some specific barriers and the most recurrent and challenging was the lack of cooperation of class colleagues. Therefore, on the third monitoring session, the researcher asked the teachers to stage a typical situation with class colleagues, which would show how lack of co-worker cooperation made GBL adoption difficult. In this scene one teacher was clearly in favour of GBL, while another one was clearly opposed and dismissive. The third one behaved as a bystander. In this scene the pro-GBL teacher tried to argue that it was important to use games in the classroom and that they were hoping for all the colleagues to cooperate, so that game integration could take place effectively. On the contrary, the oppositional teacher kept dismissing these

requests and the colleagues' arguments. The bystander, instead, didn't really do much, if not ask questions to understand both the other teachers' viewpoints.
Once these three teachers finished staging the scene, they had a debriefing session together with the other in-training teachers to analyse the depicted scene. They confirmed that this performance really portrayed what they live in their school contexts, as the dismissive attitude of colleagues makes it difficult to adopt GBL. Hence, they discussed how to change the script of this scene, so as to make it go in a more favourable direction for the GBL enthusiast. Among the many suggested changes, a core decision was to reframe the role of the teacher who behaves like a bystander, so as to make this role more aligned with that of the pro-GBL teacher. Thus, the 3 teachers re-enacted the scene, according to the established script changes. Although the bystander's support in the scene helped the pro-GBL teacher to make their point, the dismissive teacher only barely gave in to their requests. After this second staging took place, the teachers discussed what happened in this second performance and reflected upon the effectiveness of their script changes. Although they agreed that there was a hint of change in the dismissive teacher's attitude, they acknowledged that this was only a first step towards being fully convincing. Finally, all the 8 teachers discussed about class colleague dynamics and about the potential of using theatre games for PD and for student learning.
All the transcriptions of the focus groups, of the staged scenes and of the debriefings were then analysed using the Reflexive Thematic Analysis approach.
Specifically, this means that, as the reflexive approach suggests [9], I engaged with the data and took note of some initial insights. Then, I systematically coded all the analysed texts to identify insightful features of the data. The choice for the codes was based on the data and how I interpreted their meaning. Consequently, I developed some themes as an outcome of the coding process, ensuring that each theme had a clear central organizing concept that would be distinct from the others. Then, I shared these themes with the teachers involved in the monitoring sessions and with the people responsible for the teacher community. The idea of this involvement was to make sure that these themes made sense to them and, when necessary, I would tweak the wording, so as to make it more appropriately meaningful to them too.

4. Analysis

The analysis of all the transcripts helped define 5 themes that are hereby explained and put in order, according to how the barrier addressing should take place.
1. The GBL Innovator's Self-Work: overcoming Idealism and inexperience.
To implement GBL effectively, the proposing teacher must undergo a process of personal and professional strengthening. This involves overcoming inexperience**,** by moving past the awkwardness of being a novice, and refraining from stubbornly hoping for an ideal school, in favour of a practical and pragmatic approach. Accordingly, teachers need to demonstrate their competence, because, being secure in their GBL mastery, they can argue the pedagogical sense of their choices and counter criticisms towards GBL.
2. Understanding the Conservative Colleague's dismissive behaviour
The teacher dismissing GBL is defined as "conservative", because they are perceived as a strict figure who defends traditional pedagogy as the only "functional and right" method. The conservative approach is characterized by objectivity, obsession for testing, order and predictability and, so, it becomes a refuge of certainty against the perceived "chaos" of play. Thus, their resistance is not merely a lack of interest, but functions as an emotional shield: these teachers fear that moving away from teacher-centric models will lead to a loss of control or an unmanageable workload.
3. The need for Strategic Alliances with Bystander colleagues
Bystander colleagues behave as spectators who remain neutral, but they can actually support the game-based proposal. Thus, the proposing teacher should focus on building an alliance with the bystander, before facing the conservative colleague. When the bystander steps in as a mediator and joins the GBL enthusiast in a "united front," they can persuade together synergistically, making it much harder for the resistant colleague to ignore their point.
4. The failure of Direct Persuasion: opting for an Accommodating approach
Treating the conflict between pro-GBL and pro-traditional didactics as a "battlefield", to be won through assertive persuasion or adulation only, is not really effective, since conservative colleagues are not easily swayed by direct pressure. Instead, a more successful strategy involves "extending a hand", approaching the colleague without belittling their methods. By acknowledging the distance between their positions and avoiding force, an innovator may find a "glimmer of availability" for collaboration, although this requires time and energy on the pro-GBL teachers' behalf.

5. The Principal needs to set up teacher teams according to pedagogical affinity
There is a systemic barrier in how class teacher teams are formed, which is school principals' pairing of incompatible teachers. Those prone to experimentation are not likely to get along with those who are not. Principals don't fully realize the implications of their team-building choices, but they should actually take cultural and pedagogical teacher predisposition into account.
Thus, it is possible to define an overarching theme: *Overcoming Professional resistance requires self-competence, strategic alliances, systemic changes and extending a hand to conservative colleagues.*

5. Conclusions

This study looks into the initial stage of a Teacher Action Research (Ricerca-Formazione or R-F) conducted with a teacher professional community in northern Italy between 2024 and 2025. Specifically, the focus is on 5 sessions of this R-F, during which teachers, belonging to this specific community, participated in Professional Development (PD) to understand how to do Game-based Learning (GBL). Therefore, around 80 teachers were introduced into GBL during the first 2 sessions, while 8 of them went even further by trying teaching with this approach in their classes to then participate in 3 monitoring sessions together with the researcher. Hence, these teachers carried out many practical experiences, such as theatre games, and discussed them collectively. The analysis of the focus groups and of the words used while playing during the theatre games, shows that the effective adoption of GBL is not merely a matter of literacy, but a complex process of relational and systemic transformation within the school environment. This R-F intervention facilitated the reflexivity of teachers, transforming them into co-researchers capable of analysing the specificities and constraints of their unique school environments.
Indeed, a central contribution of this study is that it shows the potential of using one of Boal's theatrical games [5] for training, as it provides a Magic Circle for educators to enact and analyse their professional oppressions as "spect-actors".
Another key contribution is that this PD experience reinforces Yaman's GBL barrier model [31], as all the themes of the analysis fall under GBL attitude, literacy and political barriers. However, this study grounds these categories with empirical examples that are valid for this specific Italian context. In fact, the thematic analysis of all the focus groups and staged interactions clarifies that overcoming co-worker resistance requires self-competence and systemic changes in how teacher teams are built. Moreover, teachers need to build alliances with the colleagues who tend to stand by, creating a synergistic front of persuasion to face the more "conservative" co-workers. Notwithstanding, while dealing with uncollaborative colleagues, teachers should always make sure they are being accommodating rather than confrontational. Overall, through this PD experience teachers got to change from feeling powerless to being aware of the complexities of the school context. Thereby, they are now more empowered, knowing how to deal with the barriers they face.
In conclusion, this study is only an initial step of an R-F, but this methodology, together with the Reflexive Thematic Analytical approach, shows how teachers can evolve their professional identity and competencies. They can indeed become instructional designers that understand the complexity of their school ecosystems and can deal with the social and organizational barriers they face, while they try integrating games in their didactics.

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Stamp-Based Gamification for Enhancing Museum Engagement and Informal Learning

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Abstract

Museums increasingly compete for visitors' attention while pursuing educational missions that depend on sustained engagement and meaningful interaction. This paper presents a stamp-based gamification model designed to increase museum engagement, support informal learning, and encourage repeat visits. The intervention combines a physical "passport" for collecting stamps with an optional QR-supported layer that enables hybrid participation and flexible visitor routes. The model was developed through course-based projects in marketing and cultural management and informed by established gamification design principles (e.g., clear goals, feedback, autonomy-supporting choices, and meaningful rewards). Each museum implementation integrates a curated route, micro-tasks and inquiry prompts linked to exhibits, and lightweight rewards (stamp collection milestones) to stimulate exploration and reflection. The approach was piloted with small visitor groups across 15 museums in Bulgaria. Feedback was collected through a mixed-method design: (1) on-site observation and immediate debriefing, and (2) structured, on-site interviews supported by a short survey form. "Recall" was operationalized as correct responses to 2-3 post-visit questions delivered via the survey form, targeting core information from the curated route. Across pilot sites, participants reported higher satisfaction and perceived involvement than in typical unguided visits, while observational notes indicated longer dwell time around selected exhibits. Post-visit responses also suggested improved short-term recall of key content addressed by the prompts. The paper concludes with operational guidelines for low-cost deployment (station placement, flow management, staff coordination, and QR integration) and discusses transferability to other cultural institutions seeking scalable, human-centric engagement tools.

Keywords: *gamification, museum education, visitor engagement, informal learning, hybrid physical-digital experience, stamp rally*

1. Introduction

Museums increasingly operate in attention-competitive environments while maintaining educational missions that require sustained visitor engagement. Museum learning research emphasises free-choice, constructivist and contextual learning, in which visitors actively construct meaning through objects, narratives, social interaction and spatial experience [1], [2], [3]. Visitor attention is a key precondition for such learning, because exhibit information must first become detectable, valuable and worth sustained consideration [4].

Despite significant advances in digitalization, many museums continue to seek effective ways to combine physical and online interactions without relying exclusively on resource-intensive immersive technologies such as virtual or augmented reality. Recent research on immersive and hybrid museum experiences suggests that immersion can also be achieved through embodied interaction, spatial exploration and playful engagement rather than technological simulation alone [5].

This paper presents the design and descriptive pilot findings from a student course project that developed a stamp-based gamification system for Bulgarian museums. The project combines traditional tangible interaction with digital extensions, offering both a physical and an online support layer. While the project originates in an educational setting, it is analysed here through a design-based research lens, positioning student work as a testing ground for scalable, low-cost user-experience solutions in cultural institutions.

The Industry 5.0 perspective is used only as a light framing device to emphasise human-centric, non-intrusive and resource-efficient engagement design: an approach aligned with sustainable museum interventions rather than technology-intensive solutions [6], [7]. The paper contributes by proposing a low-cost stamp-based model with optional QR support, reporting a multi-site pilot across diverse Bulgarian museum types, and synthesising a transferability framework for varied institutional contexts.

2. Related Work

2.1 Gamification in Cultural and Museum Contexts

In museum learning research, visitors are not treated as passive recipients of information. They construct meaning through interaction with objects, spatial sequences, prior knowledge, social context and interpretive cues [1], [2], [3]. This supports the use of short, cue-linked prompts that guide attention without imposing a rigid didactic path. The design challenge is to scaffold observation and reflection while preserving the autonomy and open-endedness of the museum visit.
Gamification is commonly defined as the use of game design elements in non-game contexts to enhance motivation and engagement [8]. In museums and cultural heritage settings, prior reviews and design studies suggest that game-based or gamified elements can be associated with improved motivation, perceived learning and visitor engagement, although effects remain context-dependent and design-sensitive [9], [10]. Many implementations rely heavily on digital interfaces, which may introduce accessibility barriers, require maintenance capacity or distract from physical exhibits.

2.2 Stamp Rallies as a Gamification Model

Stamp rallies represent a long-standing form of collectible-based gamification, particularly visible in tourism-oriented cultural routes. Checkpoint-style missions and reward structures can shape visitor behaviour and satisfaction, while also highlighting the need to balance game tasks with the primary experience of sightseeing or cultural engagement [11]. Despite their simplicity, stamp rallies embody core gamification principles such as progression, achievement, feedback and reward [12].
The model presented here deliberately uses lightweight mechanics: a curated route, a passport, visible milestones, short prompts, immediate feedback and optional rewards. These elements are designed to support attention and movement through the museum while keeping the material collection at the centre of the experience.

2.3 Hybrid Immersion and Industry 5.0

Hybrid museum experiences combine physical and digital interaction without treating immersion as dependent on a single technology [5]. A physical passport can provide the core progression mechanism, while QR access can support navigation, additional information or follow-up content. This division keeps the main interaction embodied and object-centred, and uses digital media only where it reduces friction or increases flexibility.
Within Industry 5.0, the focus shifts toward human-centric, sustainable and resilient systems [6], [7]. From this perspective, museum immersion is a socio-technical experience shaped by interaction, context and meaning-making. A low-cost physical-digital model can therefore be more appropriate for many cultural institutions than costly immersive installations.

3. Research Design and Methodology

The study was guided by three research questions: RQ1, what engagement patterns are observed and reported during stamp-based gamified museum visits; RQ2, how the optional QR-supported layer functions within pilot implementations and what forms of friction or support are observed; and RQ3, which implementation factors enable the model to be transferable across different museum types and collection logics.
The study was conducted as a course-based design project and analysed through a design-based research lens. Student teams of four to six members developed and piloted stamp-based routes in collaboration with museum staff. The research design prioritised ecological validity in real museum settings and methodological triangulation through observation, structured on-site interviews and a short survey administered immediately after participation.

3.1 Design Process and Pilot Sites

The design process followed four iterative phases. First, teams conducted context analysis of museum mission, target audiences, exhibition themes, spatial constraints and visitor flow. Second, they selected stamp stations, defined tasks or prompts and aligned these with learning cues. Third, they developed

the physical passport, stamp logic and optional QR-supported layer. Fourth, they conducted on-site testing and rapid refinements based on visitor and staff feedback.
Quality assurance measures included a shared design rubric used across teams, covering clarity, safety, accessibility and museum fit; screening of prompts for factual accuracy by supervising instructors; and a minimum set of comparable post-visit questions used to operationalise engagement and recall across sites.

Table 1. Pilot-site categories and implementation logic.

Institutional group	Sites included	Typical route logic	Evaluation sources
Art and galleries	4 sites: National Gallery Square 500; Sofia City Art Gallery; SAMS; Vaska Emanuilova Gallery	Artwork/detail identification, interpretive prompts and stamp milestones.	Observation, interview, survey and R1 recall.
History and archaeology	4 sites: National Historical Museum; Regional History Museum Sofia; National Military History Museum; Archaeological Park Serdika	Chronological or object-based route with factual micro-quiz and identification tasks.	Observation, interview, survey and R1 recall.
Literature and house museums	2 sites: National Literary Museum; Ivan Vazov House Museum	Room-, author- and object-based narrative prompts supporting reflection and recall.	Observation, interview, survey and R1 recall.
Science and natural history	5 sites: Polytechnic Museum; Museum Earth and Man; Mineralogy Museum; Astronomical Observatory; Natural History Museum	Specimen-, concept- and observation-based tasks with optional QR support.	Observation, interview, survey and R1 recall.

3.2 Data Collection, Measures and Coding

Data collection combined three on-site sources captured immediately after the activity: structured observation of route-following and attention patterns around selected exhibits; short structured interviews; and a brief survey form containing Likert items, one open-ended item and recall questions. Observers recorded whether participants followed the curated route, completed stations and spent visibly extended time at target exhibits. Field notes documented breakdowns such as unclear station placement, crowding and spontaneous visitor comments.
The observation protocol treated dwell time as a contextual indicator rather than as a precise behavioural metric. Observers noted stops, returns, visible comparison between objects and prompts, and bottlenecks at stamp points. These notes were later interpreted only in combination with interview and survey responses, which reduced the risk of overstating observational impressions as outcome measures.
The interview protocol captured perceived engagement, clarity, perceived learning value and concrete improvement suggestions within one to two minutes. It included prompts on the clearest part of the route, places where visitors experienced friction or confusion, whether the stamps changed how they looked at the exhibits, and whether a QR-supported layer would be useful.
Recall was operationalized as correct responses to a small set of route-linked questions. R1 was recognition-based and coded correct or incorrect using a pre-specified answer key per site. R2-R3 were short-answer items coded for semantic alignment with the intended cue in the curated route; borderline cases were discussed between the lead researcher and the relevant student team.
Qualitative data from interviews and open-ended survey responses were analysed through thematic coding. The initial codebook covered engagement drivers, friction points, route clarity, perceived learning and implementation constraints, and was iteratively refined. A subset of responses was double-coded and disagreements were resolved through discussion. Likert-type items were summarised descriptively at site level and across sites, without inferential testing because pilot groups were small, heterogeneous and not randomly assigned.

Table 2. Measures and coding scheme used across pilot sites.

Construct	Instrument / item(s)	Scale / coding	Interpretation
Engagement and involvement	E1-E5 short survey	Likert 1-5	Higher scores indicate stronger self-reported engagement and intention to recommend or revisit.
Route clarity and usability	E2-E3 plus interview prompts	Likert 1-5 plus thematic codes	Used to identify spatial, linguistic and procedural friction.
Recall recognition	R1 post-visit	Correct / incorrect	Immediate recognition of a core cue from the curated route.
Recall open	R2-R3 post-visit	Semantic alignment 0/1 plus notes	Captures salient remembered content and memorable stations.

Construct	Instrument / item(s)	Scale / coding	Interpretation
Dwell-time cues	Observation notes	Contextual indicators	Triangulation only; not treated as stand-alone outcome.

3.3 Field Protocol, Participants and Ethics

To support comparability, teams followed a shared field protocol: provide the passport and a one-minute explanation at entry; allow visitors to complete the route at their own pace with minimal researcher interaction; conduct a short on-site structured interview immediately after the route; administer the short survey on a mobile device; and capture brief observation notes on dwell-time cues and bottlenecks without recording personally identifiable information.
Participants were recruited on-site using convenience sampling and voluntary opt-in. Pilot groups were small and heterogeneous, reflecting real-world museum visitation patterns such as students, families and tourists. The study involved minimal-risk, non-invasive feedback collection in public museum settings. Participants were informed about the purpose of the activity and the voluntary nature of participation, consent was obtained prior to interviews or survey completion, no sensitive personal data were collected, and responses were anonymised for analysis and reporting.

4. Analysis and Results

4.1 Implementation Vignettes

The National Gallery Square 500 case illustrates how stamp stations can be embedded into a large room-based gallery visit. The route balanced autonomy, through multiple possible pathways, with light guidance through a curated sequence of stations. Recognition tasks, short interpretive prompts and stamp milestones provided immediate feedback, while optional QR access offered route information without requiring dedicated hardware.
At the National Historical Museum, stations were aligned with a chronological narrative and key artefacts. Tasks were primarily factual and recognition-based, using micro-quiz prompts linked to exhibit labels. The design emphasised clarity and low cognitive overhead so that diverse visitor groups could follow the route with minimal staff mediation.
The National Museum of Natural History used a question-led scavenger format encouraging visitors to search for answers across halls and display cases. Stations were tied to distinctive specimens and explanatory panels, making the format suitable for families and student groups. Stamps served as progression markers, and the QR layer was reserved for follow-up information and route navigation.
The National Literary Museum case demonstrates transferability to institutions organised as networks of related sites, such as house museums. The literary passport logic supports both single-visit engagement and continuity across multiple locations by framing the experience as an ongoing collection of cultural checkpoints. Narrative prompts connected exhibits to authors, works and biographical episodes.

4.2 Cross-Site Patterns

Across the 15 pilot sites, triangulation of self-reports, interview notes and observational records suggested three recurring non-causal patterns. First, route-following appeared more consistent when stations were spatially legible and tasks were short, requiring one prompt and one action. Second, perceived engagement was higher when stamps acted as immediate feedback and milestones rather than purely decorative collectibles. Third, immediate recognition recall was strongest when prompts pointed to a single salient exhibit detail, such as a date, symbol, material or narrative cue, and the post-visit question mirrored that cue.
The mixed-method design helped distinguish enjoyment of the game mechanics from attention to museum content. Visitors commonly described the activity as guiding and making the visit purposeful, while observers recorded visible stops, returns or longer attention cues around exhibits explicitly referenced by prompts. Where QR support was used, it primarily reduced friction through navigation and optional follow-up information rather than replacing the physical route.

Table 3. Cross-site descriptive results from pilot implementations.

Site	n	Engagement M(SD)	Clarity M(SD)	R1 correct	QR used	Main friction point
National Gallery Square 500	12	4.45(.64)	4.12(.38)	58.3%	16.7%	Staff coordination for stamp availability
Sofia City Art Gallery	10	3.64(.61)	3.47(.66)	80.0%	10.0%	Station discoverability in crowded areas
Sofia Arsenal Museum (SAMS)	9	4.12(.59)	3.41(.31)	66.7%	33.3%	Station discoverability in crowded areas
Vaska Emanuilova Gallery	9	3.87(.53)	4.34(.40)	66.7%	44.4%	Staff coordination for stamp availability
National Historical Museum	8	4.11(.42)	3.48(.77)	75.0%	50.0%	Prompt clarity / language level
Regional History Museum Sofia	6	3.60(.62)	3.93(.36)	66.7%	16.7%	Queue/bottleneck at stamp point
National Military History Museum	11	3.76(.62)	3.77(.56)	72.7%	18.2%	Queue/bottleneck at stamp point
Archaeological Park Serdika	12	4.28(.73)	4.47(.60)	83.3%	16.7%	Queue/bottleneck at stamp point
National Literary Museum	12	3.55(.48)	3.87(.44)	75.0%	25.0%	Staff coordination for stamp availability
Ivan Vazov House Museum	9	4.04(.41)	4.36(.34)	77.8%	44.4%	Station discoverability in crowded areas
Polytechnic Museum (Sofia)	9	3.51(.68)	4.25(.66)	77.8%	11.1%	Staff coordination for stamp availability
Museum Earth and Man	12	3.62(.70)	4.15(.47)	58.3%	25.0%	Staff coordination for stamp availability
Mineralogy Museum	10	4.09(.46)	4.07(.49)	80.0%	50.0%	QR scanning friction: connectivity / device
Astronomical Observatory, Sofia University	10	3.74(.45)	3.45(.66)	60.0%	30.0%	Station discoverability in crowded areas
National Museum of Natural History	8	4.40(.54)	4.08(.65)	62.5%	37.5%	QR scanning friction: connectivity / device
Overall / weighted	147	3.92(.63)	3.96(.61)	70.7%	27.9%	Multiple site-specific constraints

Note. Engagement and clarity were measured on 1-5 Likert-type scales. R1 correct and QR used are reported as percentages of valid responses at each site. The overall row reports weighted descriptive summaries across the 15 pilot sites (N = 147).

4.3 Descriptive Findings and Implementation Constraints

Across the 15 pilot sites, 147 participants completed the post-visit survey. Engagement ratings were generally positive (weighted M = 3.92, SD = 0.63), while route clarity was similarly rated above the midpoint of the scale (weighted M = 3.96, SD = 0.61). Immediate recognition recall was correct in 104 of 147 valid responses (70.7%). QR access was used by 41 of 147 participants (27.9%), suggesting that QR access functioned as a supplementary layer rather than as the main driver of activity.

The most frequent implementation constraints were station placement competing with existing signage or crowding, varying staff availability for brief onboarding and uneven mobile connectivity affecting the optional QR layer. To strengthen validity, the study relied on immediate post-visit measurement, comparable core survey items across sites and triangulation of visitor accounts with observation notes. However, the evidence remains preliminary because the pilots used small groups, prioritised feasibility over experimental control and did not employ a randomised comparison condition.

4.4 Site-Level Interpretation

The art and gallery sites showed that stamp logic can work even in object-rich spaces, but only when stations are visible without competing with existing signage. National Gallery Square 500 had the highest engagement rating in this group, while Sofia City Art Gallery and SAMS revealed the importance of station discoverability in crowded areas. The results suggest that gallery implementations should prioritise visual-detail prompts that are immediately verifiable through looking at the artwork itself.

History and archaeology sites benefited from object-based or chronological route logic. The Archaeological Park Serdika case combined high route clarity with the highest recognition recall value in the pilot, which is consistent with the use of spatial wayfinding and identification tasks. In contrast, the National Historical Museum highlighted the need to calibrate prompt language, especially when factual micro-quiz items must remain accessible to mixed visitor groups.

The two literature and house-museum sites indicate that the model can support narrative routes rather than only factual identification tasks. In these settings, the passport becomes a device for connecting rooms, objects, authors, works and biographical episodes. The main implementation challenge is that narrative prompts must remain brief enough to fit the rhythm of a house-museum visit while still supporting reflection.

Science and natural-history sites showed the strongest need for balancing observation tasks with conceptual explanations. Mineralogy Museum and the National Museum of Natural History displayed relatively high QR use, but also made connectivity and device friction visible. This suggests that the QR layer should remain optional and should duplicate, rather than replace, the minimum information needed to complete the physical route.

Overall, the site-level evidence supports a conservative interpretation: the model appears feasible across different institutional logics, but its success depends less on the stamp mechanism alone and more on the alignment among station placement, prompt design, staff coordination and visitor flow.

5. Discussion

The descriptive findings suggest that stamp-based gamification can function as a low-cost hybrid museum experience in which engagement emerges from embodied interaction, narrative progression and playful discovery rather than from technology-intensive simulation. This interpretation is strongest where stations are spatially legible, prompts are directly tied to observable exhibit cues and stamps provide immediate feedback without distracting from the exhibits.

The evaluation supports design utility and transferability rather than causal inference. Pilot groups were small, self-selected and heterogeneous, and the study did not include random assignment or a controlled comparison condition. Therefore, observed engagement, recall and dwell-time patterns cannot be attributed causally to the intervention. Self-reported engagement may also reflect novelty and social desirability, while dwell-time cues are contextual proxies rather than precise behavioural measures.

Trustworthiness was strengthened through a shared field protocol, pre-specified answer keys for the recognition recall item, an explicit qualitative codebook, double-coding of a subset of responses and triangulation across surveys, structured interviews and observation notes. Student reflections were treated as contextual design evidence rather than primary outcome data, and field interactions were kept minimal to reduce expectancy effects.

Adapting the model to other museums requires sensitivity to local cultural norms, technical infrastructure, educational priorities, visitor density and staff capacity. Negative cases and boundary conditions are important. The model is likely to underperform when visitor flow is already constrained, when routes are too long relative to typical visit duration, when station placement creates queues or when staff capacity is insufficient to maintain stamp stations. For young children, a mediator such as a parent or educator may be needed to prevent the activity from becoming purely completion-oriented.

Table 4. Transferability parameters: stable and adaptable elements.

Stable parameters (should remain consistent)	Adaptable parameters (site-specific tailoring)
Curated route with limited station count; prompts tied to observable exhibit cues; milestone feedback through stamps; short post-visit reflection; non-intrusive facilitation and minimal researcher interaction.	Station count and spacing; reward framing; visual identity of passport; QR depth (none, light or rich); prompt difficulty and language; survey delivery channel; staff involvement intensity.

6. Operational Guidelines and Future Work

The pilot results point to several practical guidelines for low-cost deployment. First, station placement should be decided jointly with museum staff and tested during normal visitor flow, because a theoretically meaningful location may still fail if it is hidden, crowded or too close to existing signage. Second, the number of stations should be limited; a short route with clear prompts is more likely to support attention than a comprehensive route that attempts to cover the entire exhibition.

Third, onboarding should be brief and consistent. A one-minute explanation at entry is sufficient when the passport design makes the task sequence visible. Fourth, stamps should function as feedback and milestones rather than as a separate reward economy. The collectible element is useful when it marks progress, but it may undermine learning if visitors focus only on completion. Fifth, the QR layer should be treated as optional infrastructure. Its strongest role in the pilot was to reduce friction through navigation or follow-up information, not to replace the physical passport.

Future iterations should test streamlined routes and alternative prompt formats in high-density settings. They should also include delayed recall after 24-72 hours, stronger instrumentation of dwell time and QR interactions, and comparison conditions that distinguish the effect of the stamp route from the effects of novelty, instructor presence or museum type.

Table 5. Operational deployment guidelines.

Implementation issue	Guideline	Reason
Station placement	Place stations where they are visible but do not obstruct movement or signage.	Reduces discoverability problems and bottlenecks.
Prompt design	Use one short prompt linked to one observable exhibit cue.	Supports attention and immediate recall without cognitive overload.
Staff coordination	Assign a clear responsibility for stamp availability and visitor onboarding.	Prevents breakdowns in the physical route.
QR integration	Use QR codes for optional navigation, accessibility or follow-up content.	Prevents the digital layer from displacing object-centred engagement.
Evaluation	Collect a brief post-visit reflection and one recognition item.	Keeps assessment feasible while documenting design utility.

7. Conclusion

This study provides preliminary, design-oriented evidence that stamp-based gamification can be used as a pragmatic strategy for structuring attention, route-following and immediate reflection in museum visits. Descriptive findings from 147 post-visit surveys across 15 Bulgarian sites indicate generally positive self-reported engagement and route clarity, but the design does not allow causal inference about learning gains, dwell-time increases or repeat visitation.

The model value lies in its low-cost physical passport, optional QR support and prompts tied to observable exhibit cues. Its transferability is conditional: it is most appropriate when stations can be made spatially legible, routes remain short, staff coordination is feasible and QR use is treated as optional rather than required. Under these conditions, the approach could provide a practical basis for international collaboration and comparative research on tangible, human-centred gamification in informal learning settings.

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Playful Learning as a Bridge between Coding and Mathematics in Teacher Education

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Abstract

Recent Italian curricular guidelines emphasize an interdisciplinary approach in STEM education grounded in learning-by-doing and the use of digital and playful resources. Within these guidelines, Informatics is recognized as a conceptual core of Mathematics Education from early schooling, highlighting the need to integrate computational and mathematical thinking from the outset of teacher education. Computational thinking shares key dimensions with mathematical thinking, and Playful Learning can act as a pedagogical bridge between them, supporting disciplinary integration through engaging learning experiences. This qualitative exploratory case study, involving pre-service primary school teachers, examines collaboratively designed digital games on spatial orientation created with the Octostudio app. The instructional design included collaborative prototyping and game design integrating playful dimensions through the Playful Experiences framework. A thematic qualitative analysis of game prototypes and related activities was conducted to identify experiential profiles of designs' playful dimensions and the stimulated cognitive operations through the R-I-Z-A model. Findings suggest that designing playful activities can mediate between content knowledge and promote the development of professional competence.

Keywords: *Playful Learning; computational thinking; mathematical thinking; teacher education; educational game design*

1. Introduction

Computational thinking (CT) entered educational discourse with Wing's [1] seminal Communications of the ACM article and a subsequent elaboration, Wing [2] defined CT as "the thought processes involved in formulating problems and their solutions so that the solutions are represented in a form that can be effectively carried out by an information-processing agent" (p. 20). With this definition, CT is framed as a thought process, not merely as a set of coding techniques, and, more than that, as a fundamental skill for everyone — alongside reading, writing, and arithmetic — thereby grounding the K-12 educational agenda that would follow.

Subsequent scholarship has sought to operationalise Wing's broad vision through more granular taxonomies. Ng and colleagues [3], working within the Mathematics Education community, converge on a four-component characterisation that is particularly useful for primary-school contexts: problem solving, abstraction, pattern recognition, and algorithmic thinking. Hence, CT is understood as a structured form of reasoning that decomposes complex problems, recognises regularities, formulates step-by-step procedures, and evaluates outcomes systematically.

Within the Italian context, where the present study takes place, CT has entered the official educational agenda through successive policy waves. The National Guidelines for the first cycle of instruction [4] already referred implicitly to algorithmic reasoning within Mathematics. More explicitly, the STEM Guidelines [5] and the draft of the New National Guidelines for the first cycle of instruction [6] identify CT and digital literacy as transversal competences to be cultivated from early schooling, recommending playful and hands-on pedagogies. These policy documents resonate with Trinchero's influential position paper [7], which argues that the pedagogical value of CT in Italian primary education resides not in coding per se, but in the opportunity to make children's reasoning processes visible and discussable through the algorithmic activities.

All these institutional changes have brought to the fore the need to prepare primary school teachers to face the newly arisen challenges. And this preparation should start from their academic journey.

The present study aims not only to address emerging future teachers' needs, but also investigates how playful coding activities could be a suitable conceptual space to integrate Mathematics and computational thinking. Participants in this exploratory case study design digital games for primary

school kids using the Octostudio app. While future teachers engage in such design processes, they strengthen their knowledge of disciplinary aspects and reflect on meaningful ways to integrate play, Mathematics, and Informatics into classroom activities. Given the small number of participants, the short duration of the activity, and the focus on three collaboratively developed prototypes, the study should be understood as an exploratory case study. Its aim is not to generalize outcomes to pre-service teacher education as a whole, but to examine how a specific pedagogical design can make visible possible connections between playful learning, computational thinking, and mathematical reasoning.

2. Theoretical Framework

2.1 Playful Learning as a Pedagogical Framing

Playful Learning, which — building on a long tradition of play scholarship from Piaget [8] and Vygotsky [9] through Sutton-Smith [10] — has received a robust contemporary articulation in the influential theoretical piece by Zosh et al. [11]. Zosh and colleagues propose a conceptualisation of play as a spectrum. Guided play has been proven as a uniquely productive configuration for domains — such as spatial thinking — that require both exploratory freedom and conceptual targeting. The theoretical rationale of guided play rests on the "science of learning" pillars [12]: learning is optimised when experiences are active (minds-on), engaging (without being distracting), meaningful, socially interactive, and iterative. Play, when scaffolded appropriately, is a unique cultural form in which these five conditions co-occur naturally.

Within the broader literature on Playful Learning, a growing body of research focuses specifically on the affordances of play and game-based design for STEM education [13]. The argument is twofold. Empirically, STEM content — particularly spatial and algorithmic reasoning — lends itself naturally to enactive, exploratory learning configurations that playful settings support. Theoretically, play establishes the psychological protective frame [14] that allows learners to engage with cognitive risk — to try a solution, fail, iterate — without the affective cost that such failure carries in conventional assessment-oriented settings. For coding in particular, where debugging - recognizing and fixing errors - is a constitutive practice, the protective frame of play transforms errors from stigmatising events into productive resources [15].

Pelizzari [16] articulates a complementary argument within the Italian educational context: playful learning, videogames, and gamification provide pedagogical configurations in which disciplinary content, active methodologies, and affective engagement mutually reinforce one another. For teacher education specifically, Pelizzari argues, engaging pre-service teachers as designers of playful learning experiences — rather than merely as consumers of them — is a privileged route for the development of the pedagogical reflexivity that distinguishes reflective from technical practitioners.

This design-oriented stance resonates with the constructionist tradition inaugurated by Papert [17] and extended by Kafai and Resnick [18], according to which learners construct knowledge most powerfully when they are concurrently engaged in the construction of external, shareable game prototypes. In such a perspective, the prototype is not an outcome but a medium of thought, and its design-oriented manipulation is constitutive of learning itself. For pre-service teachers, this means that designing a game is a learning process — not merely a rehearsal for future teaching.

2.2 Analytical Frameworks: PLEX AND R-I-Z-A

In this study, we adopt two analytical frameworks through which playful experiences and cognitive operations involved in game prototypes will be systematically described: the Playful Experiences (PLEX) framework and the R-I-Z-A model. The choice of these two frameworks is motivated by three considerations. First, both frameworks are designed to capture observable features of learning activity, making them suitable for the thematic analysis of designed digital games that constitute the methodological core of this study. Second, both are decomposable into fine-grained descriptors, which afford sub-categorical analysis. Third, and most importantly, the two frameworks originate in distinct research traditions (experience design and cognitive pedagogy, respectively) and cover non-redundant dimensions (what is experienced and what is done cognitively).

The PLEX framework was initially developed by Korhonen et al. [19] building on a pre-existing pleasure framework for interactive art. Korhonen and colleagues re-grounded the framework on a wider theoretical base encompassing work on pleasurable experiences, game experiences, emotions, elements of play, and the reasons why people play. The revised framework includes 22 experience

categories — ranging from Captivation, Challenge, and Completion to Fellowship, Sensation, Fantasy, and Subversion — designed to capture the diversity of playful experiences that interactive products can elicit. In a given interaction, multiple PLEX categories can co-activate, and the presence or absence of one category can reinforce or weaken the others. Moreover, PLEX is proposed not as a fixed checklist but as a scaffold for discussion and ideation, a position that justifies the adaptive, domain-sensitive selection of six categories — Sensation, Competition, Discovery, Fellowship, Exploration/Experimentation, Fantasy/Narrative — that we adopt for the analysis of primary-school educational games. Although PLEX was originally developed for user experience evaluation, it has been successfully mobilised in design-oriented activities [20] [21]. In teacher education, this design-oriented use is especially relevant: it provides pre-service teachers with a lexicon for articulating the playful qualities they intend to foreground in their digital games, thereby transforming play from a vague motivational attribute into a multi-dimensional, discussable property of the design.

The R-I-Z-A model, developed by Trinchero [7] [22] within the Italian pedagogical tradition of authentic assessment and competence-based education, offers a taxonomy of cognitive operations observable in school learning activities. The acronym, taken from Italian, refers to four nested families of operations: Risorse (Resources, R), Interpretazione (Interpretation, I), aZione (Action, Z), and Autoregolazione (Self-regulation, A). The Resources family (R) includes basic cognitive operations that allow learners to activate and mobilise prior knowledge and to process perceptual input. These operations concern the identification and organisation of relevant elements in a task. They include processes such as recognising, identifying, locating, and selecting. The Interpretation family (I) includes operations aimed at constructing meaning and understanding relationships between elements. These involve analysing information, comparing elements, inferring implicit meanings, and explaining connections within a given context. The Action family (Z) includes active and productive operations through which learners apply knowledge and strategies to perform a task. These include executing, planning, constructing, describing, and classifying. The Self-regulation family (A) includes metacognitive operations that enable learners to monitor, evaluate, and regulate their own learning processes. These include arguing, justifying, motivating, criticising, and finding errors in one's own work.

Trinchero [22] has explicitly mobilised the R-I-Z-A model in relation to computational thinking, arguing that CT-oriented activities offer privileged occasions for the observation of all four families of cognitive operations, provided that the activities are structured so as to render the children's reasoning processes publicly available for discussion.

3. Method

To fulfill the stated research aim, we conducted an exploratory qualitative case study in a Primary Education course in Italy. Participants were eight students, pre-service primary school teachers, in their third year of study. Participants worked collaboratively, split into three groups (G1, G2, G3). They had former experience with designing digital games, offered within the course itself, but they had no prior experience with computational thinking or Octostudio. Octostudio is a free mobile coding app developed by MIT Media Lab [23]. Available on smartphones and tablets, it allows users to create games or other interactive projects. Users are first invited to select a sprite and a background, then directed to the main app interface. The upper part shows the game's backdrop and the sprites involved, the central part is a clean area for block-based coding, and the lower part contains all available blocks, grouped into seven distinct categories, each distinguishable by color. These categories are: starting blocks, motion, words and sounds, scenes, colors and lights, control, and others. Some of these blocks are particularly suitable for integrating playful dimensions into the games. Moreover, created projects can be easily shared and opened by others in the Octostudio app. All these features led us to identify Octostudio as a suitable app for developing playful digital games, compared to other well-known apps such as Scratch. Blocks use an accessible language and rely on intuitive icons. The block shape allows for an easy identification of main, secondary, and intermediate blocks, which can be combined to create instruction sequences.

Prior to the beginning of the classroom activities, participants were administered a short questionnaire, filled in individually, to collect information on their prior knowledge. From their answers, we know that six of them had heard of computational thinking before the experiment, whilst all of them had already heard of coding. Three of them stated they knew what coding is, even though only one out of the three had already practiced it.

The classroom activity lasted in total 2.5 hours. Students were introduced to computational thinking, the selected dimensions of PLEX, and Octostudio. Then the collaborative design phase took place. Students worked all with the same backdrop, depicting a crossroads with a lake in the bottom left corner. Students were requested not only to design a digital game but also to include it within a short educational activity.

They were supported in this task by a structured template designed by the researchers themselves, which already provided students with learning objectives from National Guidelines for Mathematics [4] and from the draft of the New National Guidelines [6] for Informatics. These objectives can be formulated as summarized in Table 1, where they are already connected to the cognitive operations outlined in the R-I-Z-A framework.

Table 1. Summary of Mathematics and Informatics objectives of the Italian curriculum connected to R-I-Z-A operations

Math objectives	R-I-Z-A operation	Info objectives	R-I-Z-A operation
Communicate objects position in space	Recognizing and arguing	Examine and interpret simple algorithms	Analyzing
Execute a simple path	Executing	Explain an algorithm and its result	Analyzing
Describe a path or give instructions to someone to follow a path	Arguing and planning	Write an algorithm and translate it into code	Planning and constructing

Students were invited to select their objectives among the listed ones. These prescriptive choices were intended to direct students' efforts towards relevant, playful, and educational elements of the activity. The main interface of the three prototypes is shown in Figure 1. The game design phase was followed by peer feedback: students exchanged their prototype with another group, and they were requested to provide feedback on the other group's game again using the structured template. The activity was concluded by a classroom discussion led by the two researchers.

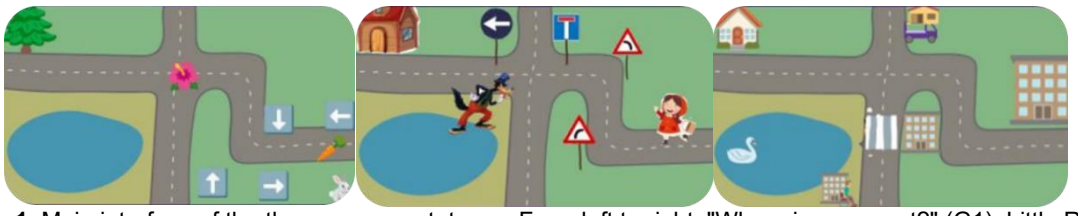


Fig. 1. Main interface of the three game prototypes. From left to right: "Where is my carrot?" (G1), Little Red Riding Hood (G2), and Let's go to school (G3).

Data collected throughout the activity include pre-questionnaire responses, Octostudio game prototypes, and templates for the playful activity (with game design activity and peer feedback). The research questions we aim to answer are:

1. How can playful coding foster both CT and mathematical reasoning?
2. Which PLEX dimensions and R-I-Z-A operations are most evident in student-designed games?

The qualitative analysis of the collected data was conducted following the six-phase procedure of Braun and Clarke [24]. An inductive categorization of the three prototypes and templates led to the identification of the predominant PLEX dimensions and so to the definition of the experiential prototype profiles. A deductive coding of the R-I-Z-A operations was conducted by triangulating data across design templates, prototypes, and peer evaluations. Finally, the emerging PLEX dimensions salient in the prototypes were associated with a set of typically co-activated R-I-Z-A operations in an integrated map. The qualitative analysis was initially conducted by the first author, who coded the prototypes, design templates, and peer feedback by identifying the predominant PLEX dimensions and the corresponding R-I-Z-A operations. The second author then reviewed the coding scheme, the attribution of categories, and the interpretation of the evidence across the three prototypes. Validation was therefore carried out as an iterative peer-debriefing process rather than as an independent statistical reliability procedure. Disagreements mainly concerned the explicit connection between some R-I-Z-A operations and the disciplinary learning objectives, especially when the operation was only implicitly embedded in the prototype. These cases were discussed jointly by the two authors, returning to the original templates and prototypes, until a shared interpretation was reached. When an operation could not be sufficiently supported by the available data, the coding was revised or its intensity level was reduced.

4. Results

The thematic analysis of the collected data produced a double-layered account of pre-service teachers' design activity: (i) the experiential layer of the playful encounters envisaged by the designers, described through the PLEX framework; and (ii) the cognitive layer, classified according to the R-I-Z-A model, which captures the interpretive, action-oriented, and self-regulatory operations that each prototype is designed to make potentially observable during gameplay. Such operations refer to those aspects that children-users might engage with while playing with the prototypes and are explicitly connected to disciplinary aspects.

4.1 Experiential Profiles of the Three Prototypes through PLEX

The three developed game prototypes, all targeted at the learning objectives related to spatial orientation, path description, and execution of simple algorithms. An inductive categorisation — developed through constant comparison across digital prototypes and templates — produced the following PLEX classification, which will serve as the interpretive backbone of the subsequent analysis:

G1 – "Where is my carrot?" is an execution-oriented game. Players guide a rabbit sprite toward a carrot target through directional commands issued under time pressure, with scoring based on execution speed. Mathematics is mobilised in its elementary topological dichotomies (left/right, up/down); computational thinking appears as the execution of short command sequences with immediate feedback (sounds, applause, score increments).

G2 – "Little Red Riding Hood" is a narrative-oriented game. The fairy-tale frame provides a pretext for introducing street signs that function as symbolic constraints on the path: planning the block sequence requires children to interpret conventional signs and translate them into actions executable in Octostudio. Mathematics enters here as symbolically mediated spatial relations, while CT manifests as pre-execution planning and instruction-to-block translation.

G3 – "Let's go to school" is the most explicitly collaboration-oriented prototype. The game simulates the home-to-school bus route and introduces two complementary roles: the navigator, who plans and describes the route verbally, and the driver, who executes the received instructions. This game architecture enforces the decoupling of algorithm design from its execution, rendering the computational process socially distributed and thus observable in its verbalisation.

This inductive categorisation reveals that although the groups started from the same input, the resulting prototypes diverged considerably. Rather than covering all PLEX dimensions, the three groups charted complementary design trajectories, each covering specific PLEX dimensions. This distributional complementarity has pedagogical implications: rather than searching for a single "best" playful design, teacher education may benefit from exposing pre-service teachers to a palette of playful configurations, each carrying a distinct experiential and — as the next section shows — cognitive signature.

4.2 The Activated Cognitive Operations through R-I-Z-A

The R-I-Z-A coding of cognitive operations yielded the synoptic matrix presented in Table 2. Qualitative recurrence is expressed through three intensity levels (✓ present but limited; ✓✓ moderate/recurrent; ✓✓✓ very frequent/central to the game).

Table 2. Summary of R-I-Z-A operations in the three games with associated intensity levels

R-I-Z-A Descriptor	G1 – Carrot	G2 – Little Red Riding Hood	G3 – School
Recognizing (R – Risorse)	✓ arrows as directions	✓ road signs	✓ school as target
Locating (R – Risorse)	✓✓ positions on the grid using arrows (start/goal)	✓ obstacles and path segments along the route	✓✓ positions and paths in realistic routes
Identifying (R – Risorse)	✓ carrot as target	✓✓ signs as constraints	✓ stops along the journey

Analyzing (I – Interpretazione)	✓ post-game discussion	✓✓ detecting errors with signs	✓✓ cooperative debugging
Arguing (I – Interpretazione)	✓ guided reflection	✓ explaining the signs	✓✓✓ verbalizing the route
Justifying (I – Interpretazione)	✓ "why right?"	✓ route-sign coherence	✓✓ discussed corrections
Executing (Z – Azione)	✓✓ use of arrows to define path	✓ blocks as short sequences	✓✓ driving the bus
Planning (Z – Azione)	✓ trial-and-error actions	✓✓ block sequences	✓✓✓ the path to school
Constructing (Z – Azione)	✓ (limited strategies)	✓ creative use of blocks	✓✓ overcoming obstacles
Finding errors (debugging) (A – Autoregolazione)	✓ wrong arrows	✓✓ incorrect use of signs	✓✓ cooperative correction
Motivating (A – Autoregolazione)	barely evident	✓ goals made explicit	✓✓ navigator motivates choices

Table 2 reveals three distinct patterns, each convergent with the corresponding PLEX profile. G1 concentrates strongly on the Locating/Executing axis, i.e. on the procedural-perceptual side of the R-I-Z-A model, with weak activation of self-regulatory structures. G2 redistributes the cognitive centre of gravity onto the Identifying/Planning/Analysing axis: the street signs, as symbolic constraints, require preliminary interpretive work (recognising the symbol as a sign, identifying its rules of use) and sequential planning (ordering the blocks consistently with the constraints). G3 is the only prototype that reaches the ✓✓✓ threshold in two operations (Planning and Arguing), distributed across distinct cognitive structures (Z and A). The navigator role, obliged to verbalise the route in a form that is publicly justifiable to the driver, transforms argumentation from an optional post-hoc activity into a structural device of the gameplay itself.

These patterns empirically substantiate the hypothesis that the ludic architecture of a prototype is not neutral with respect to the repertoire of cognitive operations it makes available — it shapes it in depth [22]. Choosing among an execution-oriented, narrative-oriented, or collaboration-oriented experience determines which R-I-Z-A descriptors find a natural habitat in the game and which remain latent or must be elicited by the teacher's external intervention. This finding has direct consequences for the main claim of the paper: if Playful Learning is to function as a bridge between coding and Mathematics, then the kind of bridge built depends critically on the kind of playful architecture chosen.

4.3 The Integrated PLEX × R-I-Z-A map

The analytical core of this study lies in the systematic mapping of correspondences between experiential dimensions (PLEX) and cognitive operations (R-I-Z-A). Table 3 presents the integrated map, associating each PLEX dimension salient in the prototypes with a set of typically co-activated R-I-Z-A operations, illustrated with concrete examples drawn from the three games.

Table 3. PLEX × R-I-Z-A map

PLEX Dimension	Associated R-I-Z-A Operations	Examples from the Games
Competition	Executing (rapid procedures); Finding errors (quick debug); Calculating (score, moves)	G1: rabbit reaches carrot under time pressure with score; children quickly correct wrong moves.

Sensation	Recognizing (visual/auditory stimuli); Locating (targets in space); Describing (what happened)	G1: applause and the words “right/left” as immediate reinforcement; G3: bus and school graphics to be identified.
Discovery	Identifying (new elements/routes); Hypothesizing (alternative solutions); Constructing (different strategies)	G2: exploration crossroads backdrop and the use of road signs; children try alternative solutions.
Fellowship	Arguing (explaining choices); Justifying (decisions); Organizing (roles and strategies); Planning (sequences together)	G3: the navigator justifies instructions to the pilot; pairs discuss strategies engaging in metacognitive reflection.
Exploration/Experimentation	Analyzing (errors, difficulties); Designing (new procedures); Finding errors (cooperative debugging)	G2: children test sequences of blocks and correct them; G3: if a wrong road is taken, children try another sequence.
Fantasy/Narrative	Describing (stories/routes); Representing graphically (maps); Explaining (causal chains)	G2: children narrate the route; G3: children narrate the journey to school.

The integrated map reveals a non-arbitrary, theoretically motivated correspondence between the two frameworks. PLEX dimensions with a strong competitive/sensory component (Competition, Sensation) tend to co-activate operations from the interpretation (I) and action (Z) structures of R-I-Z-A model, especially in procedural form. Dimensions with a strong social and reflective component (Fellowship, Exploration) predominantly mobilise self-regulation (A) operations — those that require verbalisation, justification, and public defence of one's own choices. Narrative and discovery dimensions (Fantasy/Narrative, Discovery) instead bind to operations of construction and hypothesis-formation, positioning themselves in an intermediate zone where mental representation (describing, hypothesising) precedes and informs action (planning, ideating).
A theoretically central implication follows: designing an educational game in PLEX terms is not an isolated aesthetic or motivational choice, but a curricular decision that predetermines the class of cognitive operations the children will be invited to exercise. Choosing to foreground Fellowship in the design necessarily entails a high probability of activating A operations (arguing, justifying); choosing to foreground Competition entails instead a high probability of activating Z operations in rapid, executive form. The two configurations are not hierarchically ordered but functionally distinct, and they require the teacher-designer to make an informed, intentional choice about the cognitive profile the game is meant to promote. In this sense, the integrated PLEX × R-I-Z-A map operationalises the very "bridge" announced in the paper's title: Playful Learning connects coding and Mathematics not generically, but through specific experiential-cognitive pathways that can be consciously selected and designed.

5. Discussion

The first substantive finding of this study concerns the nature of the relationship between computational and mathematical thinking in the three prototypes. Despite their divergent ludic architectures, the three groups converged on the directions/paths binomial as the conceptual bridge between the two disciplinary domains. This convergence is not accidental: it supports the thesis that computational thinking acts as a boundary object between Mathematics and Informatics [3], with algorithmic thinking functioning as a catalyst for the integration of the two fields. In the created prototypes, the sequential motion of a sprite in space constitutes simultaneously mathematical practice (coordinates, directions) and computational practice (sequence, iteration). The three prototypes differ, however, in the degree of algorithmic explicitness they require of the child. In G1 the algorithm is implicit and instantaneous: children act on the arrows in real time without having to formalise a sequence in advance. In G2 the algorithm becomes semi-explicit: the Octostudio blocks are assembled before execution and can be inspected and modified, but the planning process is individual or tacitly shared within the group. In G3 the algorithm reaches maximum explicitness through the forced verbalisation imposed on the navigator: the sequence must be said aloud, received, understood, and executed by another agent. This gradient demonstrates that the social architecture of the game — rather than the technological features of the platform — determines the level of formalisation and therefore the epistemic quality of the computational thinking activated [11].

The role of Octostudio should therefore be interpreted carefully. Some findings are mainly related to the affordances of the tool: the block-based interface supported the construction of visible instruction sequences; the possibility of combining sprites, backgrounds, sounds, and movement blocks facilitated immediate feedback and sensory engagement; and the mobile format made rapid prototyping accessible within a short classroom activity. However, other findings depend on the pedagogical design of the task. In particular, the collaborative organisation of the groups, the use of a common spatial backdrop, the requirement to connect the game to curriculum objectives, the structured design template, and the peer-feedback phase shaped the experiential and cognitive profile of the prototypes. Thus, Octostudio functioned as an enabling environment for playful coding, but the observed connections between PLEX dimensions and R-I-Z-A operations emerged from the interaction between the tool's affordances and the instructional design.

On the mathematical side, a parallel enrichment is observed: from elementary topology (G1: right/left as binary oppositions) to spatial symbolism (G2: signs as conventional marks that reorganise space) and finally to everyday geography (G3: real paths, relations between familiar places). This spectrum closely mirrors the Italian curricular guidelines in which primary-school mathematics is reframed as a tool for reading everyday experience rather than as an abstract discipline [4] [5] [6]. Playful Learning, when articulated through carefully designed prototypes such as those analysed here, provides a concrete pedagogical mechanism through which this reframing can be operationalised in teacher education [16].

A second theoretically salient finding concerns the trade-off observed between immediate engagement and cooperative depth. G1 maximises sensory-competitive engagement but sacrifices collaboration; G3 maximises cooperation but pays a cost in experiential fluency; G2 sits in an intermediate position, with both dimensions underdeveloped. This triangulation echoes Lazzaro's [25] distinction between hard fun, easy fun and people fun, suggesting that a single game rarely optimises all types of ludic pleasure simultaneously. The trade-off has important didactic implications. If the predominant formative goal is the automation of simple mathematical-spatial procedures (rapid recognition of directions, consolidation of coordinates), an execution-oriented design in the G1 style is not only acceptable but functionally appropriate: competitive reinforcement sustains the repeated practice that automation requires. Conversely, if the goal is the development of metacognitive and argumentative competences, a collaboration-oriented design in the G3 style — even if technically less polished — turns out to be cognitively richer. The design choice is therefore not between a "better" and a "worse" prototype in absolute terms, but between distinct and potentially complementary learning profiles within the broader curricular economy. Notably, the peer evaluation exchanged among groups surfaced this complementarity even in the absence of an explicit theoretical scheme. Peers asked G1 to increase its cooperative component, G2 to strengthen children's agency, and G3 to improve perceptual clarity: each group, in other words, implicitly invited the others to fill their least developed PLEX dimension. This suggests that the PLEX space functions as a shared coordinate system even among designers who have not been formally trained on the framework — an encouraging finding for the pedagogical scalability of the approach in teacher education programmes.

Finally, we acknowledge the exploratory and context-specific nature of our findings. Our research focus is on designing digital games and its potential as learning process. The study does not aim to measure long-term effects on pre-service teachers' professional competence, nor does it test the designed prototypes with primary school children. These limitations of the current study could become valuable future research directions.

5.1 Limitations and Future Research

Several limitations should be acknowledged. First, the study involved a small group of eight pre-service primary school teachers and was conducted within a single teacher education course. The findings are therefore exploratory and context-specific and cannot be interpreted as generalizable evidence of the impact of playful coding activities on teacher education.

Second, the activity lasted 2.5 hours and resulted in three initial game prototypes. Consequently, the study documents an early design experience rather than a complete process of professional competence development. It does not measure long-term changes in pre-service teachers' pedagogical knowledge, mathematical knowledge, computational thinking, or professional identity.

Third, the prototypes were analysed as designed learning artefacts and were not tested with primary school children. For this reason, the R-I-Z-A operations identified in the analysis should be understood as potential or designed-for cognitive operations, rather than as empirically observed learning processes enacted by children during gameplay.

Fourth, the analysis relied on prototypes, design templates, peer feedback, and classroom discussion. Although these data sources allowed triangulation across different traces of the activity, future studies could include video observations, interviews, longitudinal follow-up, and classroom implementation with children in order to examine how the designed experiential-cognitive pathways are actually enacted in educational practice.
Future research should therefore extend the study in two directions: by following pre-service teachers over a longer period to examine whether and how playful coding design contributes to professional competence development, and by testing the prototypes with primary school children to investigate their actual effects on mathematical reasoning, computational thinking, collaboration, and self-regulation.

6. Conclusions

The most original contribution of this study, in our view, lies in the combined use of two frameworks that — although rooted in distinct research traditions (PLEX in user experience research; R-I-Z-A in the Italian pedagogical tradition of authentic assessment) — exhibit significant complementarities. PLEX provides a rich vocabulary to describe what happens at the experiential level during playful interaction; R-I-Z-A provides an equally rich vocabulary for describing which cognitive operations that interaction activates. Their combination affords a two-dimensional analysis that neither framework, taken alone, makes possible. Such combination operates in both directions: as a tool of ex post evaluation (question: "given a game and its experience, which cognitive operations are actually activated?") and as a tool of ex ante design (question: "if we want to activate specific cognitive operations, which experiential configurations should we design?"). In the latter sense, Table 3 can be read as a first nucleus of design patterns in the spirit of Arrasvuori et al. [26]: a grammar of correspondences that helps the designer navigate the decision space more consciously. Even teacher educators might benefit from using the PLEX × R-I-Z-A map when designing or evaluating similar activities in future courses.
More concretely, teacher educators could use the PLEX × R-I-Z-A map in three complementary ways. First, before the design activity, the map can function as a planning tool: educators may ask pre-service teachers to identify which cognitive operations they want children to activate and then select the PLEX dimensions most coherent with those operations. For example, if the goal is to promote argumentation and justification, Fellowship and collaborative game mechanics may be prioritised; if the goal is to consolidate rapid execution of spatial procedures, Competition and Sensation may be more appropriate. Second, during the design activity, the map can support formative feedback by helping pre-service teachers revise their prototypes in relation to the intended experiential and cognitive profile. Third, after the activity, it can be used as a peer-evaluation grid, enabling pre-service teachers to discuss not only whether a game is engaging but also which forms of mathematical and computational reasoning it makes possible.
For initial teacher education, this dual lens offers reflections on what a "cognitively deep game" should be, provides criteria for peer evaluation among pre-service teachers, and enables targeted design iteration: peer feedback can be translated into specific modifications of ludic components. These advantages together support the professional development trajectory foregrounded in the rationale of the study: from Playful Learning as a pedagogical framing, through coding-mathematics integration as a disciplinary bridge, to reflective design practice as a professional competence.

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Unlocking Digital Electronics: A Hybrid Educational Escape Room Approach to Vocational Learning

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Abstract

Vocational Electronics education increasingly requires pedagogical approaches capable of connecting conceptual understanding, practical reasoning, and learner engagement. However, teaching practices in this field often remain centred on transmissive models that insufficiently reflect students' digital cultures, collaborative ways of learning, and the applied nature of vocational education. This study examines the pedagogical potential of a hybrid Educational Escape Room designed to support the learning of number systems, logic gates, and digital circuits among tenth-grade vocational students. Grounded in game-based and active learning principles, the intervention combined digital tasks, physical clues, collaborative challenges, and a culturally situated narrative inspired by Guimarães Castle and the historical figure of Mumadona Dias. The study adopted a mixed-methods design, integrating quantitative evidence on academic performance and usability with qualitative data on students' perceptions, motivation, collaboration, and learning experience. The design was informed by prior research on educational escape rooms as structured game-based learning environments and by evidence suggesting that escape-room activities can enhance motivation and learning in computing and technical domains. Results indicate gains in academic performance and high perceived usability, alongside strong student reports of engagement, collaborative participation, and consolidation of core concepts in digital electronics. Qualitative findings suggest that the hybrid format, narrative framing, time-bound challenges, and puzzle progression helped students attribute meaning to abstract technical content while developing transversal skills such as communication, teamwork, and problem-solving. The study contributes to current debates on innovation in vocational education by showing how hybrid Educational Escape Rooms can support more active, situated, and collaborative forms of electronics learning when carefully aligned with curricular objectives, usability principles, and opportunities for conceptual consolidation.

Keywords: *Educational Escape Rooms; Hybrid Learning Environments; Gamification; Vocational Electronics Education; Game-Based Learning.*

1. Introduction

Vocational education occupies an increasingly strategic position within contemporary educational systems, particularly in technologically intensive fields such as Electronics. As digital infrastructures, automation systems, and embedded technologies continue to evolve, so too must the pedagogical approaches through which foundational concepts—including number systems, Boolean logic, and digital circuits—are taught. Yet instruction in many vocational classrooms remains predominantly expository, privileging transmission over participation and procedural replication over conceptual understanding.

Within Portuguese vocational education, these challenges are intensified by the distinctive profile of learners, who often respond more productively to practical, contextualised, and action-oriented pedagogies. The resulting tension between traditional pedagogical models and digitally mediated learning cultures calls for structured, theoretically grounded innovation rather than ad hoc technological adoption.

Despite growing interest in Educational Escape Rooms, existing research has predominantly focused on general education contexts, with limited attention to vocational STEM domains. Furthermore, few

studies have systematically examined hybrid configurations combining physical and digital components, particularly in relation to conceptual learning rather than engagement alone.
Educational Escape Rooms (EERs) have emerged as a promising response to this challenge. By integrating game-based learning, collaborative problem-solving, narrative immersion, and technological mediation, EERs have the potential to transform abstract technical content into situated and meaningful learning experiences. A hybrid EER extends this format by combining digital and physical elements within a coherent learning design, such that online interaction, material artefacts, and embodied action work together in support of intended educational outcomes.
This study addresses these gaps through the design, development, implementation, and evaluation of a hybrid EER for tenth-grade students enrolled in vocational Electronics, focused on number systems, logic gates, and digital circuits, and embedded within a historical-cultural narrative inspired by the Castle of Guimarães and the figure of Mumadona Dias. In doing so, it advances both empirical and design-based knowledge on the pedagogical use of hybrid Educational Escape Rooms in vocational STEM education. The study was guided by four research questions: (RQ1) How can core Digital Electronics concepts be epistemically and pedagogically structured within a hybrid EER? (RQ2) What design issues emerge during expert review? (RQ3) To what extent does the resource demonstrate usability and pedagogical viability for classroom integration? (RQ4) How do students experience the hybrid EER in terms of engagement, collaboration, and perceived conceptual understanding?

2. Literature Review

2.1 Vocational Electronics as a Pedagogical Design Challenge

Vocational education is frequently defined by an imperative to connect theoretical knowledge with situated practice, developing both technical and transversal competences for employability [1]. However, classroom practices often remain predominantly transmissive, with limited scope for learner participation and meaning-making [3]. These conditions can be especially detrimental in abstract technical domains such as number systems, Boolean logic, and digital circuits, where conceptual learning requires sustained engagement and iterative reasoning.
The study is informed by three complementary perspectives. First, game-based learning (GBL) provides the basis for examining how challenge, feedback, progression, and narrative can be aligned with curricular goals. Secondly, self-determination theory offers a lens for understanding how the intervention may support autonomy, competence, and relatedness [15]. Thirdly, sociocultural perspectives on learning foreground the collaborative and dialogic character of problem-solving. However, there remains a lack of pedagogical models that effectively translate these theoretical principles into structured learning designs within vocational Electronics.

2.2 Educational Escape Rooms as Hybrid Epistemic Environments

EERs can be interpreted as a designed sequence of interdependent problems requiring learners to mobilise concepts, test hypotheses, and coordinate actions under constraints. In STEM education, EERs are frequently reported to increase involvement and active participation by embedding curricular tasks within time-bound collaborative missions [12]. The conceptual value of EERs depends on whether puzzles are epistemically aligned with disciplinary structures rather than merely entertaining.
Contemporary EERs have evolved from logic-only puzzle rooms to more immersive and technologically mediated experiences, including hybrid and virtual formats. Platforms such as Genially are often highlighted for rapid development of narrative pathways and multimedia interactivity [19], while physical components afford embodied interaction that anchors abstract reasoning in observable phenomena.
Despite these potentialities, EER design involves risks including cognitive overload, time-pressure effects, and inequitable participation [7]. Effective EER design must therefore balance challenge with cognitive accessibility, ensuring that all learners can engage meaningfully and equitably. Nevertheless, much of the literature treats EERs primarily as engagement-enhancing tools, with limited attention to their epistemic design and alignment with disciplinary knowledge structures.
This study addresses these gaps through the design: (i) limited research in vocational STEM contexts; (ii) insufficient focus on hybrid physical-digital escape room designs; and (iii) a lack of empirical evidence linking EERs to conceptual understanding rather than engagement alone. To address these gaps, the present study adopts a design-based and mixed-methods approach

3. Method

3.1 Design and Procedure

This study employed a development-oriented research design [18] to design, refine, and evaluate a hybrid EER for vocational Electronics. The study adopts a design-based research (DBR) orientation, combined with a quasi-experimental comparison to examine both design validity and learning outcomes. The development cycle comprised: (i) prototype conception aligned with curricular outcomes; (ii) expert review and iterative refinement; (iii) usability evaluation; (iv) implementation in an authentic classroom setting; and (v) impact analysis.
The intervention followed a standardised sequence comprising briefing, mission completion, and structured debriefing. Students worked in small teams of three to four for approximately 90 minutes. The teacher assumed the role of facilitator, providing support only when necessary. A mixed-methods case-study approach with a quasi-experimental non-equivalent groups design was adopted, comparing a pilot class exposed to the EER with a control class receiving conventional instruction.

3.2 Participants and Context

The study was conducted at a secondary school within regular vocational education provision. Two 10th-grade vocational classes participated: a pilot group from the Professional Course in Computer Systems Management and Programming Technician (n = 14) and a control group from the Professional Course in Electronics, Automation and Computers Technician (n = 9), yielding a total of N = 23 participants aged 14–17 years. All participants were male, reflecting the demographic composition typical of the participating vocational programmes. The all-male composition of the sample reflects programme demographics and is acknowledged as a limitation regarding generalisability.

3.3 Instruments

Data were collected using a set of complementary instruments. A motivation questionnaire adapted from the Science Motivation Questionnaire II (SMQII) [10] assessed baseline motivational dispositions. Pre-test and post-test knowledge assessments enabled estimation of short-term learning gains. System usability was assessed through the System Usability Scale (SUS) [6]. A structured observation protocol recorded indicators of engagement, collaboration, and problem-solving. A feedback questionnaire and focus-group protocol captured students' perceptions of the experience. All instruments demonstrated acceptable internal consistency.

4. EER Design and Development

4.1 Conception and Narrative

The EER "The Lost Code" was designed as a hybrid pedagogical resource, integrating a digital component developed on the Genially platform and a physical component—a 3D-printed box housing an electronic circuit based on an Arduino Uno board. The design was guided by principles of active learning, gamification, and user-centred design [11].
The framing narrative draws on the historical figure of Mumadona Dias, the countess who founded the Castle of Guimarães in the 10th century. Students are challenged to decipher a secret code hidden within the castle's stones. This historical-cultural dimension provides a contextualised and meaningful framework, linking Digital Electronics content with Portuguese cultural heritage within a STEAM logic.

4.2 Mission Organisation and Game Progression

The EER is organised into five virtual rooms inspired by symbolic spaces associated with the Castle of Guimarães. Progression follows a conditional sequential logic: access to each room depends on the correct resolution of previous challenges, ensuring a gradual increase in difficulty and phased consolidation of knowledge. Table 1 summarises the mission structure, and Fig. 1 illustrates the reading of the letter attributed to Mumadona Dias, which introduces the narrative mission and contextualises students within the historical setting.

Table 1. Mission organisation of the EER "The Lost Code"

Room	Curricular Content	Challenge Type	Outcome
Entry Tower	Number systems: binary, decimal, hexadecimal	Multiple-choice conversion	Fragment 1
Library	Logic gates: truth tables and symbolic representations	Association matching	Fragment 2
Museum	Logic circuits: Boolean expressions and circuit diagrams	Circuit analysis	Fragment 3
Royal Workshop	Physical logic gate identification	Hands-on: switches, LEDs, truth table	Fragment 4
Keep Tower	Integration of all content	Sequential code entry via digital padlock	Mission complete



Fig. 1. Letter introducing the mission of the hybrid EER “The Lost Code”, AI-generated and adapted by the author using ChatGPT.

4.3 Digital and Physical Components

The digital component was developed on the Genially platform, enabling integration of multimedia elements, interactive challenges with conditional progression logic, and a digital padlock system. The visual design evoked the medieval atmosphere of the Castle of Guimarães. Accessibility features included user-controlled audio settings, minimum reading time constraints, multimodal cues combining visual elements and textual information, and consistent layout structures to minimise extraneous cognitive load.

The physical component consists of a 3D-printed box, modelled in Autodesk Fusion 360 and printed with PLA filament. Inside, an Arduino Uno-based circuit includes two input switches and three output LEDs, allowing students to manipulate input states, observe output behaviour, and empirically construct the circuit’s truth table. The “hidden” logic gate can be changed by the teacher through simple code modification, reinforcing resource versatility and reusability. Figure 2 illustrates both the digital interface and the physical component of the hybrid EER.

This component fulfilled a clear epistemic function: enabling students to establish explicit connections between symbolic representations and observable system behaviour, supporting hypothesis testing, inference, and iterative reasoning.



Fig. 2. Hybrid EER "The Lost Code": (left) Library room, AI-generated and adapted by the author using ChatGPT; (right) physical component.

5. Resource Validation

5.1 Expert Review and Iterative Refinement

The expert review process involved four specialists with over 18 years of experience: two from Computing and two from Electrical Engineering. Each specialist independently interacted with the EER following a structured expert walkthrough protocol organised around seven heuristic dimensions adapted from Nielsen [13]. Table 2 summarises the main findings and corresponding redesign decisions.

Table 2. Expert review findings and redesign decisions

Spec.	Finding	Redesign Decision	Severity
S1	No clear indication of mission progress	Added visual progress indicators (padlocks + markers)	Major
S2	Background music could disrupt concentration	Implementation of user audio control	Minor
S3	Entry Tower too demanding as entry point	Adjustment of difficulty level	Major
S4	Museum task was overly complex and risked disengagement before students had processed the instructions	Adjusted difficulty and instruction timing	Major

5.2 Usability Evaluation

Following iterative refinement, the EER's usability was evaluated using the SUS [6], administered to eight students from other year groups. Results revealed a mean SUS score of 86.18 (SD = 3.90), with individual scores ranging from 80.00 to 92.50. This mean score places the system within the Excellent category (Grade A), exceeding both the 80.3-point threshold identified by Bangor et al. [2] and the 68-point benchmark for acceptable usability. Item-level analysis showed particularly positive ratings for ease of use (M = 5.00), user confidence (M = 4.63), and systemic integration (M = 4.63).
As the SUS was administered to students from other year groups, the results provide evidence of perceived usability but should not be interpreted as direct evidence of learning effectiveness among the intervention participants.

6. Results and Discussion

6.1 Learning Outcomes

No statistically significant difference was found between groups in baseline motivation, $t(21) = -0.095$, $p = .925$, confirming initial equivalence. Regarding academic performance, the pilot class improved from a mean of 56.36 (pre-test) to 63.38 (post-test), whereas the control group showed only a modest increase of less than two points. Although between-group differences did not reach statistical significance—attributable to the small sample size—the descriptive gain pattern is consistent with a possible positive contribution of the hybrid EER to short-term learning gains. Although statistical

significance was not achieved, the observed trend suggests a possible practical effect, warranting further investigation with larger samples.

6.2 Motivation, Engagement, And Collaboration

Across data sources, a consistent pattern emerged: students described the activity as more dynamic and involving than conventional instruction, and observation records indicated active participation, sustained attention, and persistence. The escape-room structure required coordinated participation, negotiation of meaning, and shared decision-making, supporting what sociocultural perspectives describe as learning through participation [16]. From the perspective of self-determination theory, the intervention can be interpreted as supporting autonomy (through problem-solving), competence (through progressive challenge and feedback), and relatedness (through collaborative interaction) [15]. These findings align with self-determination theory, suggesting that the design supported intrinsic motivation through structured challenge and social interaction.

6.3 Perceived Contribution of Hybridity and Narrative

One of the most distinctive findings concerns students' perceptions of the hybrid and narrative dimensions. Participants highlighted the value of combining digital progression with physical manipulation, suggesting that the interaction between the Genially-based environment and the electronic box contributed to making abstract Electronics concepts more intelligible and meaningful. Rather than functioning as a superficial motivational layer, the narrative acted as a structuring device that linked tasks, supported progression, and contextualised abstract content, extending existing work on culturally situated storytelling in technical learning contexts [17].
The physical component functioned as an epistemic tool enabling learners to connect symbolic representations with observable system behaviour—supporting hypothesis testing, inference, and iterative reasoning central to conceptual understanding in Electronics [14].
This finding is particularly relevant, as it suggests that hybridity is not merely a technological enhancement but a pedagogically meaningful design feature.

7. Discussion

The findings of this study are interpreted in relation to the four research questions that guided the investigation.
Regarding RQ1, the five-room conditional progression demonstrated that Digital Electronics content can be systematically embedded within a hybrid EER, connecting number systems, truth tables, Boolean expressions, and circuit behaviour within a coherent pedagogical sequence. The alignment between the narrative arc and the curricular scope ensured that each room contributed a conceptual building block, supporting the kind of structured challenge-feedback loop identified as central to effective game-based learning [11, 12].
Regarding RQ2, the expert review process surfaced critical design issues — particularly related to difficulty calibration and progress visibility — that would likely have compromised engagement and learning if left unaddressed. The iterative refinement cycle adopted here reinforces the value of structured expert evaluation as a design validity mechanism prior to classroom implementation [8].
Regarding RQ3, the SUS mean score of 86.18 confirms that the hybrid EER reached a level of usability consistent with excellent classification, supporting its viability for classroom integration [2]. This finding is significant because usability functions as a necessary precondition for meaningful engagement: a resource that students cannot navigate fluently is unlikely to support the epistemic goals it was designed to serve.
Regarding RQ4, student reports of motivation, collaboration, and conceptual consolidation are consistent with evidence from comparable EER interventions in STEM and technical education [4, 14, 16]. The hybrid format appears to have added pedagogical value beyond digital-only designs by grounding abstract symbolic reasoning in observable physical phenomena. From a self-determination theory perspective [15], the intervention supported autonomy through open-ended problem-solving, competence through progressive challenge and immediate feedback, and relatedness through sustained collaborative interaction — conditions associated with intrinsic motivation and deeper engagement.
Taken together, these findings suggest that hybrid Educational Escape Rooms can function as epistemically structured learning environments rather than merely motivational tools, extending the

conclusions of recent systematic reviews [12, 19] to the specific context of vocational Electronics education. These findings should be interpreted in light of several limitations. The small sample size and the non-equivalent groups design limit the statistical power of between-group comparisons and restrict the generalisability of the results. Additionally, the all-male composition of the sample, which reflects the demographic profile of the participating vocational programmes, limits the extent to which findings can be extrapolated to more diverse learner populations.

8. Limitations

This study has several limitations. First, the sample was small, comprising 23 students distributed across two non-equivalent vocational classes. Secondly, all participants were male, reflecting the demographic composition of the programmes but limiting the transferability of the findings to more diverse learner populations. Thirdly, the absence of random assignment prevents causal interpretation of the observed learning gains. Fourthly, the pilot and control groups belonged to different vocational courses, which may have introduced differences in prior knowledge, curriculum exposure, or learner profile. Fifthly, the study examined short-term learning outcomes only; no delayed post-test was administered to assess retention. Finally, although the hybrid design appeared pedagogically promising, further research is needed to examine transfer to unfamiliar digital electronics problems and to evaluate scalability across teachers, schools, and cohorts.

9. Conclusion

This paper described the design, development, validation, and classroom implementation of the hybrid EER “The Lost Code”, conceived as a pedagogical resource for teaching Digital Electronics in vocational education. By combining a structured historical-cultural narrative, interactive digital challenges in Genially, and a physical Arduino-based electronic circuit, the intervention established a hybrid learning environment aligned with principles of active learning and game-based learning.

The validation process confirmed the technical robustness and pedagogical coherence of the resource (SUS mean: 86.18). The classroom implementation provided empirical evidence suggesting improvements in academic performance in the pilot group and, more importantly, qualitative evidence of increased motivation, active engagement, collaborative problem-solving, and meaningful interaction with abstract technical content.

This study advances the field by demonstrating that hybrid Educational Escape Rooms can function not only as engagement-enhancing strategies but as epistemically structured learning environments capable of supporting conceptual understanding in vocational STEM education. By integrating narrative, physical interaction, and digital progression, the proposed design model offers a scalable and pedagogically grounded approach for technology-enhanced learning.

Future research should involve larger and more diverse samples from different vocational education contexts in order to strengthen the generalisability of the findings. Replication studies across different technical disciplines and educational settings would help to further validate the pedagogical potential of hybrid Educational Escape Rooms as meaningful learning environments for vocational STEM education. Furthermore, longitudinal studies are needed to examine the retention and transfer of learning achieved through this approach. More robust comparative research designs could also provide a deeper understanding of the effectiveness of hybrid Educational Escape Rooms in supporting learning outcomes and student engagement in vocational STEM education.

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Beyond Accuracy and Speed: A Learning Analytics Approach to Performance Modeling in Digital Phonological Games for Brazilian Children

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Abstract

The increasing use of digital technologies in education has expanded the possibilities for assessing cognitive processes related to learning. However, performance in digital tasks is still frequently analyzed using isolated metrics, such as accuracy or response time, which may fail to capture the multidimensional nature of cognitive performance. This study proposes a composite indicator, named the Game Progress Index (GPI), designed to integrate accuracy, speed, and efficiency into a standardized measure applied to digital phonological awareness games. A total of 339 Brazilian children in the early stages of literacy development participated in the study and completed seven digital game-based tasks. Different weighting models were tested, and the model showing the strongest association with performance indicators was selected. A regression-based approach was then employed to estimate expected performance, allowing the calculation of standardized residuals and the identification of discrepancies between observed and predicted outcomes. Results demonstrated a strong association between the GPI and performance rate (r = .90), supporting the coherence and sensitivity of the proposed index. The combined analysis of percentile scores and residuals revealed heterogeneous performance profiles, including children with high overall performance but lower-than-expected outcomes, as well as participants with low overall performance but outcomes above model predictions. Findings suggest that traditional normative metrics alone may be insufficient to capture individual variability in digital learning contexts. The proposed approach offers a more sensitive framework for modeling performance in educational games, with potential implications for educational assessment, learning analytics, and game-based cognitive screening.

Keywords: *learning analytics; digital assessment; serious games; cognitive performance; phonological awareness*

1. Introduction

The increasing use of digital technologies has profoundly transformed teaching, learning, and assessment processes. In contrast to traditional paper-and-pencil instruments, digital environments enable the continuous collection of behavioral data generated during user interaction with tasks, including the number of correct responses, response times, interaction patterns, and performance trajectories [1–3]. These records, often referred to as behavioral trace data, expand opportunities to investigate the cognitive processes involved in learning and create new possibilities for the development of more sensitive and informative assessment systems [4–6].

Within this context, Learning Analytics has emerged as an important field of research dedicated to the collection, analysis, and interpretation of educational data to better understand and optimize learning processes [1,7]. Unlike traditional assessment approaches, which focus primarily on final performance outcomes, contemporary Learning Analytics perspectives seek to understand how individuals perform tasks by examining information related to cognitive processing dynamics and learner behavior throughout task execution [2].

Despite these advances, a substantial proportion of digital assessments still rely on isolated indicators to represent participant performance. Measures such as the number of correct responses, percentage of correct answers, or total completion time are frequently analyzed separately, which may limit the understanding of the multidimensional nature of cognitive performance [3]. From a theoretical perspective, performance in cognitive tasks emerges from the interaction of multiple components, including accuracy, processing speed, and problem-solving efficiency [8,9]. Consequently, individuals with similar levels of accuracy may exhibit substantially different cognitive profiles when temporal and process-related aspects are taken into account.

This issue is particularly relevant in the context of literacy acquisition. Among the various predictors of reading development, phonological awareness is widely recognized as one of the most important skills for acquiring an alphabetic writing system and has consistently been associated with reading performance across different languages and educational contexts [10,11]. In recent years, digital tasks designed to assess these skills have been increasingly adopted, facilitating automated data collection and the generation of more precise performance measures [12].

However, the availability of large volumes of data alone does not necessarily lead to advances in understanding learning processes. One of the central challenges lies in developing analytical models capable of integrating multiple dimensions of performance while producing indicators that are meaningful and interpretable for researchers and educators [5,13]. In this regard, composite metrics have been proposed as a promising alternative for representing performance more comprehensively by combining information related to accuracy, speed, and efficiency into a single synthetic indicator [3,14].

At the same time, predictive modeling approaches have gained increasing attention within the field of Learning Analytics because they enable the estimation of expected performance based on behavioral variables collected during task execution [5,15]. Comparing observed and expected performance makes it possible to identify individual discrepancies that may not be captured by traditional normative metrics. Within this framework, residual analysis represents a particularly valuable strategy, as it allows the identification of participants whose performance falls above or below the expectations established by predictive models [16,17].

Against this background, the present study proposes a Learning Analytics–based approach for modeling performance in digital phonological awareness games. To this end, the Game Progress Index (GPI), a composite metric integrating indicators of accuracy, speed, and efficiency derived from participants' interactions with digital tasks, was employed. Subsequently, a quadratic model based on Accuracy per Minute (APM) was used to estimate participants' expected performance, enabling the calculation of standardized residuals and the identification of discrepancies between observed and predicted outcomes [5,15].

Accordingly, the aim of this study was to investigate the relationship between the Game Progress Index (GPI) and Accuracy per Minute (APM), as well as to examine the potential of residual analysis for identifying performance profiles that are not adequately represented by traditional normative indicators. By integrating composite metrics, predictive modeling, and the analysis of individual discrepancies, this study seeks to contribute to the development of more sensitive approaches for game-based cognitive assessment in educational contexts.

2. Method

2.1 Study Design

This was a quantitative, observational, cross-sectional study conducted to investigate performance modeling in Portuguese-language digital phonological awareness games using a Learning Analytics–based approach. Behavioral data collected during participants' interactions with digital tasks were analyzed, including indicators of accuracy, completion time, and efficiency.

2.2 Participants

A total of 369 children in the early stages of literacy development initially participated in the study. Of these, 26 were excluded from the analyses because they presented a diagnosis or indication of neurodevelopmental disorders according to the study eligibility criteria, and 4 did not complete the assessment battery. The final sample therefore consisted of 339 children. Participants included in the analyses had a mean age of 6.45 years (SD = 0.84), ranging from 5.10 to 8.03 years. The sample comprised 170 boys (50.1%) and 169 girls (49.9%). Regarding educational level, 129 participants (38.1%) were enrolled in Early Childhood Education, 121 (35.7%) attended Grade 1, and 89 (26.3%) attended Grade 2. All participants were recruited from a private school located in São Bernardo do Campo, Brazil.

2.3 Instruments

Data were collected using seven digital games designed to assess phonological awareness skills. The games were developed by the authors and implemented within a Brazilian gamified cognitive assessment platform (https://clickneurons.com.br). Tasks were organized in a modular structure, with

each game containing either 10 or 20 items, resulting in a total of 100 items across the assessment battery. This distribution was defined according to the complexity of the skills being assessed, aiming to balance cognitive load across tasks while ensuring adequate representation of different components of phonological processing [10,11]. As shown in Table 1, the games assessed skills such as phoneme–grapheme correspondence, syllable segmentation, identification of initial and final syllables, and rhyme recognition. Tasks were presented through an interactive digital interface, with automated recording of correct responses and response times for each item, enabling the calculation of accuracy, speed, and efficiency indices.

Table 1. Organization of the digital games included in the phonological awareness assessment battery

Game ***Portuguese / English name***	**Primary Skill**	**Task Type**	**No. of Items**
Sopa de Letrinhas ***Letter Soup***	Phoneme–Grapheme Correspondence	Letter selection following an auditory stimulus	10
Toca o Som ***Touch the Sound***	Auditory Discrimination	Selection of the grapheme corresponding to the presented sound	20
Mexe a Boca ***Move Your Mouth***	Syllabic Awareness	Identification of the number of syllables	10
Correio das Sílabas ***Syllable Mail***	Initial Syllables	Matching words sharing the same initial syllable	10
Tesouro das Sílabas ***Syllable Treasure***	Initial Syllables	Matching words sharing the same initial syllable	20
Oficina das Sílabas ***Syllable Garage***	Final Syllables	Identification of the final syllable	20
O Poeta Falou ***The Poet Said***	Rhyme Awareness	Identification of rhyming words	10

During task execution, immediate feedback was provided to participants to maintain engagement and support understanding of task requirements. From a measurement perspective, the digital environment enabled the collection of detailed behavioral data, including: (a) number of correct responses (accuracy); (b) total number of items presented; (c) response time per game; and (d) total task completion time.
To increase the precision of temporal measures, the execution time used in the analyses excluded intervals not directly related to the cognitive processing demands of the task, such as transitions between stimuli, visual and auditory feedback periods, and delays inherent to interface operation. This procedure was intended to ensure that timing measures primarily reflected participants' cognitive processing and response execution, thereby reducing the influence of extraneous factors unrelated to task performance [6,14,17].
The resulting interaction data served as the basis for calculating the GPI, a composite metric developed to integrate indicators of accuracy, speed, and efficiency derived from participants' interactions with the digital games. The index ranges from 0 to 100, with higher scores indicating better performance.

2.4 Data Collection Procedures

Data collection was conducted in a school setting through individual assessment sessions administered by previously trained researchers. All participants completed the tasks using the same device model, an 11th-generation iPad with an 11-inch screen, ensuring standardized presentation of visual stimuli.
Auditory stimuli were delivered through noise-canceling headphones to minimize environmental distractions and ensure uniform testing conditions across participants. During the assessment, children completed a battery of seven digital phonological awareness games designed to evaluate skills associated with early literacy development.
Performance data were automatically recorded by the digital platform, including information related to response accuracy and task completion time. All records were subsequently exported for statistical analysis.
The study was approved by the Research Ethics Committee of the Federal University of São Paulo (Approval No. 8.132.619; CAAE No. 94688725.9.0000.5505) and was conducted in accordance with national ethical guidelines for research involving human participants. Participation was authorized by the children's legal guardians prior to data collection.

3. Results

Table 2 presents the descriptive statistics for the main variables investigated. The GPI showed a mean score of 75.01 (SD = 15.07), whereas APM presented a mean of 7.35 correct responses per minute (SD = 4.12). Performance estimated by the quadratic model showed a mean similar to that observed for the GPI (M = 75.01; SD = 14.45), suggesting good overall correspondence between observed and predicted values.

Table 2. Descriptive statistics of the main study variables (N = 339).

Variable	Mean	SD	Minimum	Maximum
GPI	75.01	15.07	40.02	99.36
APM	7.35	4.12	1.04	19.86
Predicted GPI	75.01	14.45	44.22	96.21
Quadratic Residual	0.00	4.28	-25.14	11.23

Note: GPI = Game Progress Index; APM = Accuracy per Minute; SD = Standard Deviation.

3.1 Association Between Overall Performance and Temporal Efficiency

A strong positive association was observed between the GPI and APM, $r = .913$, $p < .001$. This result indicates that participants with greater temporal efficiency tended to exhibit higher levels of overall performance in the digital tasks. The coefficient of determination ($r^2 = .834$) indicated that approximately 83.4% of the variability observed in GPI was associated with variability in APM.

3.2 Modeling Expected Performance

To estimate participants' expected performance, a second-order polynomial regression model was fitted using APM as the predictor variable. The model demonstrated an excellent fit to the data ($R^2 = .919$; adjusted $R^2 = .919$), explaining approximately 91.9% of the variance observed in the GPI (Table 3). Analysis of variance indicated that the model was statistically significant, $F(2,336) = 1916.95$, $p < .001$. The resulting equation was:

$$GPI = 36.730 + 7.475(APM) - 0.235(APM^2).$$

Table 3. Polynomial Regression Model Predicting GPI from APM

Predictor	B	95% CI	p
Constant	36.730	—	<0.001
APM	7.475	[7.03, 7.92]	<0.001
APM²	-0.235	[-0.259, -0.210]	<0.001

Both the linear APM term ($B = 7.475$, 95% CI [7.03, 7.92], $p < .001$) and the quadratic term ($B = -0.235$, 95% CI [−0.259, −0.210], $p < .001$) contributed significantly to the model. The inclusion of the quadratic term increased the model's explanatory power relative to the simple linear association reported previously, providing evidence of a non-linear relationship between APM and GPI. Figure 1 illustrates the distribution of participants and the fitted quadratic curve.

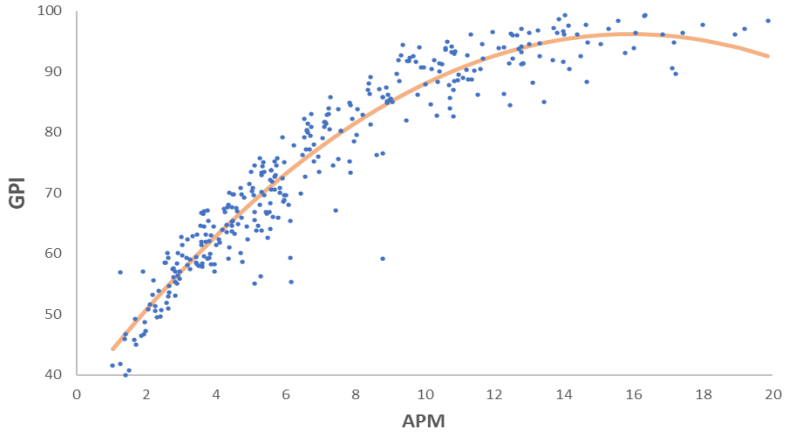


Fig. 1. Relationship between APM and GPI with quadratic model fit ($R^2 = 0.919$).

3.3 Performance Quadrant Analysis

Based on the predictive model, individual residuals were calculated as the difference between observed and expected performance. Residuals were subsequently standardized and analyzed jointly with GPI percentile ranks. Participants were classified using the 50th percentile of the GPI distribution and a standardized residual value of zero as cutoff points. The combination of these criteria allowed each participant to be positioned within a two-dimensional space defined by normative performance and discrepancy from expected performance.
The integration of percentile rank and standardized residual scores enabled the identification of four performance profiles: **Expected High**, **Unexpected High**, **Expected Low**, and **Unexpected Low**. These profiles represent distinct combinations of normative performance level and deviation from model-based expectations (Figure 2).

Table 4. Distribution of Participants Across Analytical Quadrants

Profile	n	%
Expected High	114	33.6
Unexpected High	56	16.5
Unexpected Low	74	21.8
Expected Low	95	28.0
Total	339	100.0

Note: Expected High = participants with GPI percentile rank ≥ 50 and standardized residual ≥ 0; Unexpected High = GPI percentile rank < 50 and standardized residual ≥ 0; Unexpected Low = GPI percentile rank ≥ 50 and standardized residual < 0; Expected Low = GPI percentile rank < 50 and standardized residual < 0.

Participants were distributed across all four quadrants. The discrepant groups (Unexpected High and Unexpected Low) jointly represented 38.3% of the sample, indicating that a substantial proportion of participants exhibited performance patterns that differed from those predicted by the model.

3.4 Association Between Performance Quadrants and School Grade

The distribution of participants across performance quadrants varied significantly as a function of school grade, $\chi^2(6) = 176.89$, $p < .001$. Cramer's V indicated a large association ($V = .511$). As shown in Figure 2, children enrolled in Early Childhood Education were predominantly concentrated on the left side of the analytical space, corresponding to the Expected Low and Unexpected High profiles, whereas students in Grades 1 and 2 were more frequently represented on the right side, corresponding to the Expected High and Unexpected Low profiles.

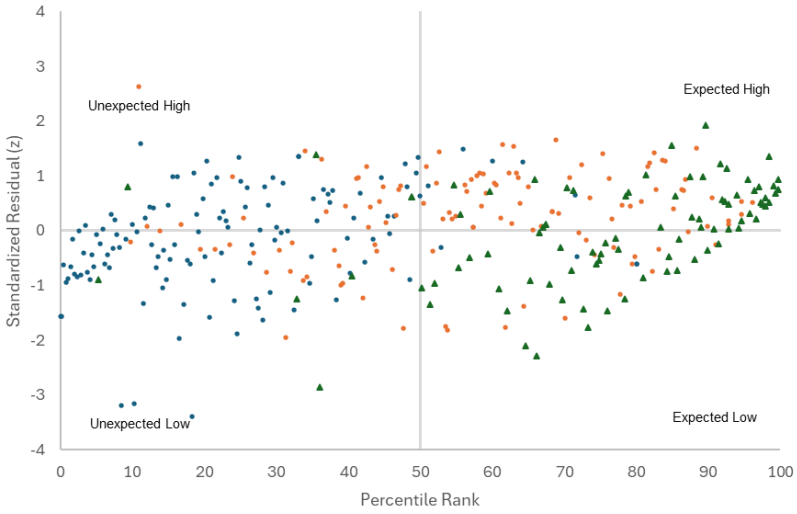


Fig. 2. Distribution of participants according to percentile rank and standardized residual scores. Blue circles = Early Childhood Education; orange circles = Grade 1; green triangles = Grade 2. Reference lines indicate the 50th percentile and z = 0 cutoffs.

4. Discussion

The present study investigated a Learning Analytics–based approach for modeling children's performance in Portuguese-language digital phonological awareness games. Results revealed a strong association between the Game Progress Index (GPI) and Accuracy per Minute (APM), as evidenced by the observed correlation ($r = .913$, $p < .001$) and the high coefficient of determination of the quadratic model ($R^2 = .919$). Taken together, these findings indicate that the integration of accuracy and temporal efficiency provides a robust representation of participants' performance in digital tasks related to early literacy development.

Traditionally, digital educational assessments rely on isolated indicators, such as the number of correct responses or total completion time. Although these measures provide valuable information, they do not always capture the multidimensional nature of cognitive performance. The findings of the present study reinforce the importance of simultaneously considering multiple dimensions of learner behavior, a perspective consistent with contemporary approaches in Learning Analytics and digital assessment [1–3]. In this context, the GPI was designed to integrate accuracy, speed, and efficiency into a single metric, generating a measure that was strongly associated with the behavioral data produced during interaction with the games.

Another important finding was the identification of a non-linear relationship between APM and GPI. The significance of the quadratic term indicates that performance gains associated with increased temporal efficiency do not occur uniformly across the distribution. Performance improved more rapidly at lower levels of APM, followed by a progressive deceleration at higher levels. This pattern is consistent with findings from cognitive performance research, in which additional gains in speed tend to yield progressively smaller improvements in overall performance [8,9].

The most relevant contribution of this study, however, concerns the analysis of discrepancies between observed and expected performance. The integration of percentile ranks and standardized residuals enabled the identification of distinct performance profiles, revealing that a substantial proportion of the sample (38.3%) exhibited patterns that diverged from model-based expectations. This finding suggests that traditional normative indicators may be insufficient to fully characterize individual differences in digital learning environments. Participants occupying similar positions within the normative distribution may nevertheless display markedly different performance profiles when efficiency patterns captured by predictive modeling are taken into account. This interpretation is consistent with recent Learning Analytics research advocating the integration of multiple sources of evidence to better understand individual differences in student performance [5,14,15].

The results also demonstrated a significant association between performance quadrants and school grade. Children enrolled in Early Childhood Education were predominantly concentrated in the lower-performance regions of the analytical space, whereas students in Grades 1 and 2 were more frequently represented in the higher-performance regions. This pattern suggests that the proposed approach is

sensitive to developmental differences expected throughout the literacy acquisition process. At the same time, the presence of participants distributed across different quadrants within the same grade level indicates that the model may also capture individual variability that is not fully explained by schooling alone.

Taken together, the findings suggest that combining composite performance indicators, predictive modeling, and residual analysis can expand the interpretative potential of data generated in digital learning environments, providing information that complements the metrics traditionally used in educational assessment.

Several limitations should be considered when interpreting the results. First, the sample consisted of Brazilian children in the early stages of literacy development, which limits the generalizability of the findings to other age groups and educational contexts. Second, the data were obtained from a specific battery of Portuguese-language digital phonological awareness games, and it cannot be assumed that similar patterns would emerge in other cognitive domains or types of digital tasks. In addition, the cross-sectional design precludes inferences regarding individual changes over time or causal relationships among the variables investigated. Finally, although the model demonstrated substantial explanatory power, further research is needed to evaluate its stability in independent samples and across different educational settings.

5. Conclusion

This study presented a Learning Analytics–based approach for modeling children's performance in Portuguese-language digital phonological awareness games. The results revealed a strong association between the GPI and APM, as well as an excellent fit of a quadratic model capable of explaining approximately 91.9% of the observed variance in performance.

The combined analysis of percentile ranks and standardized residuals enabled the identification of performance profiles that would not be readily detected using conventional normative indicators, highlighting the potential of predictive modeling to complement digital assessment practices. Furthermore, the association observed between performance quadrants and school grade suggests that the proposed approach is sensitive to developmental differences occurring during literacy acquisition.

Overall, the findings indicate that the integration of behavioral metrics, statistical modeling, and Learning Analytics can contribute to the development of more informative digital assessment systems, providing a more nuanced understanding of individual differences in educational contexts. Future studies should examine the applicability of this approach across other cognitive domains, age groups, and educational settings, further expanding the evidence base for its use in assessment and learning monitoring.

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Co-designing with Children: Intuitive Insights for Growing Minds

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Abstract

This paper examines Growing Minds as a practice-based case study exploring how co-design with children can inform the development of sustainable educational tools and support participatory forms of environmental learning. Positioned at the intersection of design research, primary education, student engagement, and games in education, the project investigates how children's intuitive actions, play behaviours, and collaborative responses can shape both the design process and the learning experience.

The study responds to the limitations of instructional approaches to environmental education, where knowledge is often transmitted as abstract information rather than experienced through participation, exploration, and agency. Drawing on constructivist learning theories, participatory design, and the Reggio Emilia approach, children are framed not only as users but as active contributors whose insights emerge through embodied interaction, experimentation, hesitation, and improvisation.

Methodologically, Growing Minds employed an iterative, play-based co-design process with children aged 5 to 9 through repeated prototyping and playtesting sessions in classroom and garden-based learning environments. Observation, field notes, photographs, and reflective documentation were used to analyse how children interacted with materials, symbols, rules, group settings, and ecological concepts. Each design cycle informed the next, allowing the tool to evolve in response to children's behaviours rather than predetermined assumptions.

Preliminary findings suggest that children's participation improved the clarity, accessibility, and pedagogical relevance of the tool. Symbolic ecological icons supported stronger conceptual connections, while smaller group settings encouraged collaboration, autonomy, and peer learning. Outdoor sessions further strengthened sensory engagement and children's understanding of environmental systems as interconnected relationships rather than isolated facts.

The paper argues that play-based co-design can function both as a design methodology and as a pedagogical framework for transformative environmental education, supporting children's agency, collaboration, and long-term ecological understanding.

Keywords: *co-design; children; play-based learning; environmental education; design thinking; iterative design; primary education*

1. Introduction

This paper examines *Growing Minds* as a practice-based case study exploring how co-designing with children can reveal broader pedagogical issues within environmental education. Although the project resulted in the development of a sustainable educational game, its significance lies not only in the final product but also in the design process itself. Children's intuitive actions, hesitations, play behaviours, and collaborative responses exposed gaps between adult assumptions and children's actual learning needs.

Positioned within the themes of games and media in education, student engagement, and primary and early childhood education, the study responds to the limitations of instructional approaches to environmental learning. Environmental knowledge is often presented as abstract information, while sustainable education requires more participatory, experiential, and action-oriented forms of learning [15], [16]. In this context, *Growing Minds* asks how educational tools can become more meaningful when they are shaped through children's lived experiences and everyday ways of understanding the world.

Drawing on constructivist learning, participatory design, game-based learning, and the Reggio Emilia approach, the paper frames children not only as users of educational materials but as active contributors to educational knowledge [1], [3], [4], [7], [8], [12]. Methodologically, the project employed an iterative,

play-based co-design process with children aged 5 to 9 through prototyping and playtesting sessions in classroom and garden-based learning environments.
The paper argues that play-based co-design can function not only as a design methodology but also as a critical lens for rethinking education. By observing children's intuitive insights, *Growing Minds* demonstrates how educational tools can support more participatory, collaborative, and environmentally meaningful learning experiences.

2. Theoretical Background

This study draws on theories of play, experiential learning, participatory design, and game-based education to position *Growing Minds* as both a design process and a pedagogical case study. Play is understood not as an activity separate from learning, but as a primary way through which children explore ideas, test relationships, and construct meaning through action and interaction [2], [3]. Dewey's theory of experiential learning is also central to this study, as it emphasizes that meaningful education emerges through direct experience, reflection, and connection with real-life situations [1]. In this sense, environmental education becomes more powerful when children do not only receive information about sustainability, but actively experience ecological relationships through materials, movement, collaboration, and problem-solving. Through this approach, *Growing Minds* seeks to help children, as future actors of society, develop environmental awareness, climate consciousness, and a sense of responsibility toward the systems they are part of.
The study is also informed by the Reggio Emilia approach, which frames children as capable, expressive, and active meaning-makers rather than passive recipients of adult knowledge [4]. This perspective supports the methodological decision to treat children's intuitive actions, hesitations, negotiations, and playful responses as valuable research data. Participatory design further strengthens this position by arguing that users and communities should take part in shaping the tools and systems that affect them [7], [8]. In the context of *Growing Minds*, co-designing with children therefore becomes more than a method for improving an educational tool; it becomes a way of revealing the gap between adult assumptions and children's actual learning needs.
Game-based learning provides the final theoretical layer of the study. Educational games can support engagement by combining rules, symbols, goals, feedback, challenge, and social interaction [12], [13]. For environmental education, this is especially relevant because ecological concepts are relational and interconnected. Through game-based experiences, children can practise cooperation, decision-making, systems thinking, and shared responsibility. Building on these perspectives, *Growing Minds* was developed as a play-based educational tool that connects environmental learning with children's everyday experiences, peer interaction, and active participation.

3. Research Aim and Methodology

The aim of this research is to examine how a sustainable educational game can be developed through children's participation and how the co-design process can reveal broader issues within current educational practices. Rather than treating *Growing Minds* only as a final game product, the study approaches it as a practice-based case study in which children's play behaviours, intuitive responses, collaborative actions, and difficulties became central sources of design and pedagogical knowledge. This approach is informed by participatory design, which positions users as contributors to the design of tools and systems that affect them [7], [8], [9].
The methodology combined secondary research, field-based observation, activity design, prototyping, and iterative playtesting. The secondary research focused on play-based learning, participatory design, game-based education, environmental education, and early childhood learning. This stage helped define the main learning goals, themes, and skill areas of the project, including collaboration, ecological awareness, decision-making, systems thinking, communication, responsibility, and the ability to connect environmental concepts with everyday actions [12], [13], [15], [16].
The primary research phase involved working with children in different school and learning environments. The names of the schools are not specified in this paper in order to protect institutional and participant privacy. Instead, the research focuses on the observed interactions and learning situations that emerged during the process. Children participated in designed activities that allowed the researcher to observe how they understood rules, used symbols, collaborated with peers, responded to materials, completed tasks, negotiated decisions, and engaged with environmental themes.
Based on these insights, the first prototype of *Growing Minds* was developed and tested with children. During the playtesting sessions, the focus was not only on whether the game functioned correctly, but

also on how children interacted with it. Their movements, questions, misunderstandings, excitement, peer communication, and problem-solving strategies were carefully observed. This process revealed gaps between adult design assumptions and children's actual learning needs, including the need for stronger visual support, clearer rules, physical action, group participation, and sensory connection with the environment.
After the first prototype test, the design was revised according to these observations. The game mechanics, visual language, ecological icons, rules, and activity structure were adjusted to make the tool clearer, more engaging, and more pedagogically relevant. A second testing cycle then examined whether the revised game could better support the targeted skills and learning goals. In this sense, the methodology was both design-oriented and educational: co-design was used not only to improve the game, but also to understand how children can engage with sustainability through action, play, collaboration, and real-life tasks.

4. Alternative Learning Models and Educational Outcomes

Before entering the field, the development of *Growing Minds* began with a secondary research phase focused on sustainability education, play-based learning, participatory design, and alternative educational approaches. This stage helped define the learning goals and skill areas that would guide the design process. The aim was not only to create a game about sustainability, but to understand how an educational tool could support children's participation, collaboration, ecological awareness, and skill development.
A key starting point was the role of education within sustainable development. UNESCO frames education as both a specific Sustainable Development Goal and a wider driver of social and ecological transformation [15]. This connects directly to SDG 4, which emphasizes inclusive and equitable quality education and lifelong learning opportunities. For *Growing Minds*, this supported the idea that environmental education should not only provide sustainability-related information, but should also help children practise responsibility, cooperation, decision-making, and ecological thinking through meaningful learning experiences.
The review of sustainable education highlighted the need to move beyond purely instructional approaches. Sterling argues that sustainable education requires more participatory, systemic, and transformative forms of learning [16]. This was important for the project because concepts such as ecosystems, interdependence, resources, and collective action can remain abstract when taught only through verbal explanation. Therefore, *Growing Minds* was designed around action-based learning, allowing children to learn through observing, collecting, matching, discussing, deciding, and solving problems together.
The project was also informed by experiential and constructivist learning theories. Dewey emphasizes the importance of experience and reflection in meaningful education [1], while Piaget and Vygotsky show that children actively construct knowledge through interaction with materials, peers, and social environments [2], [3]. This perspective shaped the project's attention to children's movements, choices, hesitations, misunderstandings, and peer interactions as meaningful signs of how learning takes place.
Play-based and game-based learning further shaped the project. Play was approached as a serious educational method through which children explore ideas, test possibilities, negotiate rules, and express understanding through action. Game-based learning literature suggests that games can strengthen motivation and engagement through goals, rules, challenge, feedback, imagination, and social interaction [12], [13]. Recent research also supports the value of well-designed games for children's cognitive, social, and learning outcomes in early childhood education [14].
The Reggio Emilia approach provided another important reference point by framing children as capable and expressive meaning-makers whose understanding can appear through multiple forms of expression [4]. This supported the decision to observe children's learning through drawing, arranging, touching, moving, storytelling, collaboration, and play. Participatory design and co-design literature also informed the methodology, emphasizing that users should help shape the tools and systems that affect them [7], [8], [9]. In *Growing Minds*, this meant positioning children not only as users of the game, but as contributors whose behaviours and responses could guide its development.
From this secondary research, several core learning goals were identified: collaboration, communication, systems thinking, problem-solving, adaptation, responsibility, sensory engagement, and self-driven action. These skills were connected to sustainability learning and to the needs of early childhood education. The secondary research therefore created an initial framework, which was later tested and refined through field observation with children.

5. Field Observations and Identified Skill Gaps

The field phase of *Growing Minds* was conducted to understand how children engage with learning tasks, environmental concepts, classroom routines, peer interaction, and play-based activities in real educational settings. The purpose was not only to test whether the game idea could function, but to observe how children learn, where they hesitate, and which skills require stronger support in early learning environments. Classroom observation, outdoor exploration, nature-based tasks, visual matching, drawing, print-making, and group-based play were used to examine how children responded to different learning situations.

The observations showed that children engaged more actively when learning was connected to movement, sensory experience, visual references, and collaborative tasks. Outdoor activities created visible curiosity and excitement, especially when children explored their surroundings, collected natural materials, and used them in creative activities. These moments suggested that environmental learning becomes more meaningful when children can physically and emotionally connect with the subject. However, the fieldwork also revealed that children often needed support in connecting abstract ideas, understanding ecological relationships, and working collaboratively rather than individually.

In classroom settings, children's learning was strongly shaped by the clarity of the task, the organization of the environment, and the teacher's guidance. Group learning became more visible when shared goals and rules were clear. However, individual work often continued even within group activities, showing that collaboration cannot be assumed simply because children are placed together. It needs to be intentionally designed through turn-taking, shared responsibilities, communication, and collective outcomes.

The first prototype testing also showed that children were able to match images and colours, but needed more support in understanding deeper relationships between categories, ecosystems, and environmental consequences. In the hexagon-based activity, children could recognize visual similarities, yet they did not always explain why certain elements belonged together or how one environmental element might affect another. This became an important design insight: *Growing Minds* needed to move beyond recognition and matching toward relational and systems thinking.

These observations helped identify the main skill gaps that the game needed to address. The skill areas were not chosen only through theory; they emerged from the combination of secondary research and direct field observation. The literature helped define the educational importance of these skills, while the fieldwork showed how they appeared in children's actual behaviours. In this sense, the game was shaped not only by adult assumptions, but by observing what children needed in order to participate more actively, understand more deeply, and connect environmental knowledge with action.

Table 1. Main skill gaps and their translation into *Growing Minds* game actions. It summarizes the five main skill gaps identified during the fieldwork and how they were translated into play-based design response

Identified skill gap	**Field observation**	**Growing Minds design response**
Collaboration and collective consciousness	Children sometimes worked individually even when placed in groups.	Shared missions and group outcomes were added to encourage cooperation and collective responsibility.
Visual connection-making	Children needed visual references to connect stories, categories, and ecological ideas.	Ecological icons, image cards, colour systems, and visual prompts were used to support conceptual links.

Systems thinking	Children could recognize separate images, but struggled to understand deeper ecological relationships.	Hexagon-based connections and environmental themes helped children see relationships between natural elements.
Problem-solving and adaptation	Children engaged more when they could test, repeat, adjust, and physically interact with materials.	Game challenges were designed around trial-and-error, flexible thinking, and active problem-solving.
Self-driven and peer-supported learning	Some children waited for adult direction, but became more active when encouraged to ask and learn from peers.	Structured choices, group tasks, and peer discussion moments encouraged initiative, confidence, and shared learning.

The findings from the fieldwork shaped *Growing Minds* as a game structured around skills, phases, and environmental themes. The main skill areas included collaboration, systems thinking, problem-solving, adaptation, and self-driven learning. The environmental themes included food and agriculture, water, and life on land, allowing children to approach sustainability through familiar and concrete subjects rather than distant or abstract concepts. The game structure therefore moved from local observation to broader ecological understanding and reflection.

The testing process also showed the importance of play-based learning as a research and design method. Play allowed children to engage with complex ideas through action rather than abstract explanation alone. When children moved, collected, matched, painted, discussed, and tested ideas together, learning became visible through behaviour. Their actions showed where the activity supported understanding and where the design needed to change. For example, the need for stronger visual references, clearer connection-making, and more structured collaboration directly informed the revision of the game.

For teachers, *Growing Minds* offers a practical way to introduce sustainability-related skills without relying only on verbal explanation or textbook-based instruction. The game provides visual materials, structured activities, collaborative missions, and adaptable learning themes. In this way, it helps teachers create situations where children can practise environmental thinking through play, action, peer interaction, and shared problem-solving.

6. Growing Minds as a Tool for Children and Teachers

After the secondary research and field observation phases, the next step was to translate the identified learning goals and skill gaps into the structure of *Growing Minds*. The design challenge was to connect sustainability-related curriculum themes with play-based actions that children could understand, practise, and build upon together. In this sense, the game was developed not only as an environmental learning tool, but also as a structured play experience supporting systems thinking, adaptation, problem-solving, collaboration, ecological awareness, and self-driven learning. This approach connects to sustainable education, participatory design, and game-based learning, which emphasize active participation, experiential learning, and social interaction [8], [12], [13], [15], [16].

The game begins with children engaging directly with their surroundings. Rather than starting from abstract information, children observe nature, collect natural elements, and use these findings as the starting point of the activity. This connects learning to place, material experience, and adaptation. From this central point, children gradually create a larger visual and conceptual map. A leaf, fruit, animal, seed, or natural object is therefore not treated as an isolated item, but as part of a wider ecological system. This supports experiential and constructivist learning, where knowledge develops through action, reflection, and interaction with the environment [1], [2], [3].

Collaboration is embedded into the mechanics of the game. Once one child places a piece, the next child needs to respond to what has already been placed by another member of the group. Children

cannot follow only an individual plan; they must observe, adapt, and continue from their peers' decisions. In this way, collaboration becomes a physical and visible action rather than an abstract educational aim. The game also supports adaptation, because children may need to change direction when another player adds a different element to the shared map.

During field activities, the game also encouraged communication and peer learning. When children could not immediately identify a fruit, plant, animal, or natural element, they began asking one another instead of waiting only for the teacher to provide the answer. This showed a shift from teacher-dependent learning toward peer-supported discovery. Through the game, children had a reason to speak, compare, explain, and help each other. This supported confidence as well as collaboration, because knowledge was created through shared exploration.

The curriculum connection is built through environmental themes such as food and agriculture, water, and life on land. These themes are concrete enough for young children to understand through everyday examples, while also introducing wider sustainability questions. Through play, children explore how plants, animals, natural resources, human choices, and environmental conditions are connected. This allows sustainability learning to become active and accessible rather than distant or abstract.

Table 2. Translation of *Growing Minds* game actions into skill development.

Game action	**Skill developed**	**Educational meaning**
Collecting from nature	Adaptation and sensory engagement	Children begin from their real surroundings rather than abstract content.
Creating a shared map	Systems thinking	Children see how natural elements connect within a bigger ecological picture.
Building on another child's move	Collaboration and adaptation	Children respond to peer decisions and continue a shared structure.
Asking peers about unknown items	Communication and confidence	Children learn from each other instead of depending only on the teacher.
Changing direction during play	Flexibility and problem-solving	Children practise adjusting their plan when the game situation changes.

In this sense, *Growing Minds* translates curriculum-based learning goals into play-based actions. Systems thinking becomes mapping and connecting; collaboration becomes building on another child's move; adaptation becomes changing direction according to the shared game situation; and ecological awareness becomes recognizing relationships between natural elements. These skills are not taught separately from the game, but are practised through the act of playing.

The value of *Growing Minds* also lies in how it changes the learning relationship between children, peers, teachers, and the environment. Children are not positioned only as receivers of information; they are learners who become explorers, contributors, and co-builders of the learning process. The teacher's role also shifts from being the only source of knowledge to becoming a guide who supports observation, discussion, group decision-making, and reflection. In this way, *Growing Minds* offers teachers a structured but flexible tool for introducing sustainability-related learning through visual materials, group missions, nature-based tasks, and curriculum-related themes.

7. Conclusion

This paper examined *Growing Minds* as a practice-based case study showing how co-design with children can support the development of sustainable educational tools for early childhood education. The project began with secondary research on sustainable education, play-based learning, participatory design, and game-based learning, which helped define the main learning goals and skill areas of the game. These included collaboration systems thinking, adaptation, problem-solving, ecological awareness, sensory engagement, and self-driven learning [12], [13], [15], [16].

The field observations and prototype testing showed that children engage more meaningfully with environmental concepts when learning is connected to action, movement, visual references, peer interaction, and direct experience with nature. The process also revealed several gaps within conventional educational settings. Children often needed stronger support in connecting abstract concepts, working collaboratively, understanding ecological relationships, and acting with confidence without depending only on teacher confirmation. These findings support the idea that sustainability education should not be limited to transmitting information, but should create situations where children can practise responsibility, cooperation, observation, and decision-making through active learning experiences [1], [3], [15], [16].

Through the development of *Growing Minds*, these educational needs were translated into play-based actions. Collecting natural elements, creating shared maps, building on peers' decisions, asking questions, and adapting to the direction of the game changing constantly allowed children to experience learning as a social and exploratory process. In this way, the game made skills such as collaboration, systems thinking, communication, and problem-solving visible through play. Co-design was therefore not only a method for improving the game, but also a way of understanding how children learn and what educational structures can better support them [7], [8].

The study suggests that play-based educational tools can support both children and teachers. For children, *Growing Minds* offers a way to explore sustainability through curiosity, movement, peer learning, and shared discovery. For teachers, it provides a structured but flexible tool for introducing environmental themes through classroom, garden, or outdoor activities. The teacher does not remain the only source of knowledge; instead, the game creates a learning environment where children can observe, discuss, test, compare, and learn from one another. This reflects the value of social learning, participatory learning, and game-based engagement in early education [3], [12], [13], [14].

Overall, *Growing Minds* demonstrates that sustainable education can become more meaningful when it is designed through children's participation and translated into concrete, collaborative, and playful actions. While this study does not claim to measure long-term behavioural change, it shows how field observation and co-design can reveal important educational needs and transform them into practical learning experiences. Future development of the project could include further testing in different school contexts, closer collaboration with teachers, and longer-term observation of how play-based tools support children's ecological understanding and participation over time.

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ICT in Education

Young Learners and AI: Deciding When to Bot

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Abstract

The AI-powered technologies, and chatbots in particular, are increasingly promoted as solutions to enduring challenges in English language teaching (ELT). While these tools are often praised for their capacity to deliver interactive and personalised learning experiences alongside traditional instruction, their rapid uptake in educational contexts has outpaced critical reflection on pedagogical readiness. The growing imperative to adopt AI raises fundamental questions about whether teachers and learners are sufficiently prepared - linguistically, cognitively, and emotionally - to engage productively with such technologies. Rather than assuming that earlier exposure is inherently beneficial, this study interrogates when *and* how *AI should be introduced to support meaningful language learning. Drawing on an on-site empirical investigation, the study examines the use of AI in English-medium Content and Language Integrated Learning (CLIL) classrooms, focusing on history and art in a bilingual school in Rome, Italy. It analyses interactions between primary (Grade 5) and lower secondary (Grades 6–7) students and AI-based tutoring tools on the SchoolAI platform. Through qualitative analysis of student–chatbot exchanges, the research critically explores how learners negotiate meaning with AI, revealing both the pedagogical affordances and the constraints of AI-mediated interaction in ELT settings. The presentation situates the study within current debates on AI in language education, challenging techno-optimistic narratives by foregrounding classroom realities. It outlines the research methodology and key findings, supported by illustrative excerpts from student-AI interactions, and concludes with a critical reflection on the implications for curriculum design and teacher decision-making*

Keywords: *AI in Education; CLIL; AI-powered tutors; Student-AI interaction; Personalised learning; Educational technology*

1. Introduction

The rapid integration of artificial intelligence into education has generated both enthusiasm and unease. AI-powered tools, especially chatbots, are increasingly framed as solutions to persistent pedagogical challenges, including learner autonomy and motivation, personalised feedback and scalable support [5], [6], [8], [20]. In English Language Teaching (ELT) and Content and Language Integrated Learning (CLIL) contexts, such technologies are often positioned as especially valuable, offering learners additional conversational practice and linguistic scaffolding while engaging with subject-specific content [1], [14].
However, the pace of technological adoption has arguably outstripped critical pedagogical reflection and there remains a lack of empirical research on the use of chatbots in ELT [16]. While AI tools are widely promoted as enhancing learning outcomes, less attention has been paid to the interaction process itself in order to understand whether these tools are genuinely pedagogically appropriate for young learners. Some concerns have already emerged regarding the standardisation of language, over-reliance on technology, data safety, ethics and responsibility [5]. This paper argues that the focus should shift from asking whether AI “works" for learning to investigating for whom, when and under what conditions it might be beneficial.
In Italy, the Guidelines for the Introduction of Artificial Intelligence in Educational Institutions recommend, while deploying AI in the support of students, to "take into account the different levels of development related to age" [15, p. 21]. This raises a central question: when are learners developmentally, linguistically and cognitively ready to benefit from AI-mediated interaction. Is it appropriate to introduce AI in primary school or is it preferable to wait until lower secondary school?
This study addresses this question through an empirical investigation conducted in a bilingual school in Rome, Italy. Focusing on primary (Grade 5) and lower secondary (Grades 6-7) CLIL classrooms, the research examines how learners interact with AI-powered tutors on the SchoolAI platform. Rather than evaluating AI solely in terms of efficiency or accuracy alone, the study adopts Vygotsky’s sociocultural perspective [17], [18] to explore the nature of artificial mediation and how meaning is negotiated in student-AI interaction. By analysing authentic classroom exchanges between learners and AI systems,

this paper seeks to move beyond techno-optimistic narratives and instead foreground the complexities of AI integration in real educational contexts with young learners. It argues that the effectiveness of AI in ELT is not determined solely by technical capability but by learners' developmental readiness and the pedagogical frameworks within which these tools are embedded.

2. Literature Review and Theoretical Framework

2.1 Growth of AI in Contemporary ELT Discourse

Recent large-scale research syntheses [7], [9], [13] confirm both the growth and diversification of AI implementation in second language education. A systematic review of AI-driven chatbots in this field [7] highlights an increase in empirical studies since 2020, reflecting the growing institutional and commercial interest in AI-supported learning environments. These tools are frequently associated with affordances such as increased learner autonomy and motivation, real-time feedback and extended opportunities for practice beyond the classroom [20].
At the same time, meta-analytic evidence [13], [19] provides a more detailed picture of their impact. In a comprehensive meta-analysis of chatbot-assisted language learning, Wang *et al.* [19] report a moderate positive effect on language learning performance (g=0,484), based on 70 effect sizes across 28 studies. However, the analysis also identifies substantial variability across contexts, suggesting that effectiveness is contingent on multiple interacting factors, including learner characteristics and instructional design. Following this line of reasoning Lyu *et al*. [13, p. 834], suggest that "a more refined perspective is needed when discussing the benefits of the use of chatbots in language learning process".

2.2 Evidence of Effectiveness

While a growing body of research report generally positive outcomes associated with chatbot use, these findings must be interpreted with caution. The meta-analysis by Wang *et al.* [19] demonstrates that chatbot-assisted learning can enhance language performance overall; however, the strength of this effect is moderated by several key variables, such as educational level, language level, interface design and interaction capability. This suggests that AI tools do not operate as universally effective pedagogical solutions but rather as context-dependent resources. Similarly, systematic reviews [7], [9], [13] emphasise that improvements are often observed in specific domains, particularly speaking, writing and listening, where opportunities for practice and immediate feedback are crucial. At the same time, these studies note that many empirical investigations are conducted in controlled or experimental settings, which may not fully reflect the complexities of real classroom environments.
A key limitation emerging from this body of research is its predominant focus on measurable outcomes, such as test scores or task completion, rather than on the processes through which learning occurs. In particular, relatively little attention has been paid to how developmental factors shape these interactions. As a result, claims regarding effectiveness often remain insufficiently grounded in an understanding of how learners actually use and interpret AI-generated input.

2.3 Chatbots as Interactional Tools

Within ELT, chatbots are frequently conceptualised as conversational partners capable of simulating authentic interaction. In their study Belda-Medina and Calvo-Ferrer [2] describe chatbots as AI-driven interlocutors that can engage learners in dialogue, thereby creating opportunities for communicative practice that might otherwise be limited in traditional classroom setting. This framing aligns with communicative and interactionist approaches to language learning, which emphasise the importance of meaningful interaction is developing linguistic competence.
However, the notion of chatbots as "partners" requires closer scrutiny. Unlike human interlocutors, AI systems do not possess genuine communicative intent. While they can generate contextually appropriate responses, these are ultimately based on algorithmic patterns rather that a shared understanding. As a result, interaction with chatbots may differ qualitatively from human interaction, particularly in terms of feedback and co-construction of meaning. This distinction becomes especially relevant when considering younger or less proficient learners whose limited metapragmatic and critical awareness may render them especially susceptible to forms of semiotic regulation embedded in AI-mediated discourse.

2.4 The CLIL Context and AI Integration

The application of AI in CLIL contexts remains relatively underexplored, despite its potential relevance. CLIL environments which integrate content and language learning, place additional cognitive and linguistic demands on learners, making them a particularly interesting site for examining the role of AI-mediated support.
Existing studies on AI chatbots in CLIL settings indicate that such tools can support both content comprehension and language development by providing explanations, prompts and feedback tailored to subject-specific tasks [1], [14]. However, these studies tend to focus primarily on the design and affordances of AI systems rather than on the process of their actual use in classroom interaction.The extent to which AI can effectively scaffold this dual demand remains unclear, particularly for young learners whose cognitive and linguistic resources are still developing.

2.5 Critical Gap

Despite the growing body of research on AI in ELT. Several critical gaps remain. First, there is a notable lack of attention to developmental factors. While studies such as Wang et al. [19] identify educational level as a moderating variable, few investigations explicitly examine how learners' cognitive, linguistic and metacognitive readiness shapes their ability to engage productively with AI systems. This is particularly important in research involving young learners. Where developmental differences may significantly influence interactional outcomes.
Second, much of the existing literature is not grounded in sociocultural approaches to learning. Drawing on Lev Vygotsky's work, learning is understood as a mediated process that occurs through interaction with more knowledgeable others within the learner's Zone of Proximal Development. From this perspective, the effectiveness of any instructional tool, including AI, depends on its capacity to provide appropriate scaffolding. However, current research rarely interrogates whether chatbots can genuinely function as mediational agents comparable to human interlocutors. This concern stems from sociocultural approaches to language learning [10], [11] [12], which argue that language development emerges through socially situated interactions rather than through exposure alone, placing a particular emphasis on the quality of interaction
Finally, there is a lack of fine-grained classroom discourse analysis. Much of the literature relies on quantitative measures or self-reported data, offering limited insight into the micro-level dynamics of student AI-interaction. As a result, important questions remain unanswered: How do learners formulate queries to AI? How do they interpret and respond to AI generated feedback? To what extent do these interactions support or hinder the negotiation of meaning?
Addressing these gaps requires a shift in focus from outcomes to processes and from technological affordances to pedagogical realities. The present study responds to this need to examining student-AI interaction in CLIL classrooms through a sociocultural lens, with particular attention to developmental readiness and the conditions under which AI can meaningfully support learning.

3. Methodology

The study adopts a qualitative classroom-based design, which focuses on interactional process. A qualitative approach was selected because the study attempted to understand not simply whether AI "works" but how AI-mediated interaction unfolds in authentic educational setting. The participants interacted with AI-tutors once a week for 30 minutes during four weeks in November, the school year 2025-2026.
Data were analysed using reflexive thematic analysis [3], [4], in which recurring interactional patterns and learner behaviours were identified across the dataset. MAXQDA software was used to facilitate coding and codes were subsequently grouped into broader analytical themes reflecting the affordances and limitations of AI-mediated interaction within CLIL environments.
The analysis was informed by a sociocultural theory [17], [18] and its application in second language development [10], [11] [12], Consequently, coding focused on themes related to mediation, scaffolding, meaning negotiation and interaction within the ZPD.
The analysis proceeded through six recursive phases:

1. Familiarisation with the data;
2. Initial coding of student -AI interactions:
3. Identification of recurring interactional patterns, mediation episodes, misunderstanding, scaffolding, prompt formulation strategies;

4. Development and refinement of themes;
5. Thematic interpretation in relation to sociocultural theory;
6. Final synthesis in relation to sociocultural theory.

Rather than examining interaction solely at the linguistic level, the analysis aimed to understand how learners engaged with AI tutors during CLIL tasks and how developmental readiness influenced the quality of interaction.

3.1 Research Context and Participants

The study was conducted in a bilingual school in Rome where English is used as a medium of instruction for selected CLIL subjects. The participants included 36 students from one primary (Grade 5) and two lower secondary classrooms (Grades 6 and 7), representing learners between 9 and 13 years of age. Their linguistic level was from A1 to B1.

3.2 AI Platform and Learning Tasks

Students interacted with AI history tutor and AI art tutor on School AI platform during classroom activities designed by the teacher. The chatbot platform was used to support content exploration, answer questions, provide explanation and assist learners in completing subject related tasks in English.
Activities included asking chatbot for explanation of historical or artistic concepts, summarising information, generating ideas and clarifying vocabulary. The AI tool functioned as a supplementary instructional resource rather than a replacement for teacher-led interaction.

3.3 Data Collection

Data were collected over four classroom sessions through chat logs, classroom observation notes and focus groups. The primary dataset consisted of chat logs. These transcripts, which documented exchanges between learner and the chatbots, allowed for closer examination of how students formulated prompts, interpreted AI responses and interactional dynamics that emerged from that. Classroom observations were used to contextualise the interactional data by recording learner behavior, moments of confusion, patterns of engagement and teacher intervention during activities. Focus groups were used to clarify the learners' perception of these activities.

4. Findings and Analysis

The analysis of the chat logs reveals a significant mismatch between AI conversational design and young learners' developmental readiness within CLIL environments. Several recurring themes emerged from the data.

4.1 AI Sustains Interaction but Not Necessarily Learning

One of the most prominent findings concerns the chatbot's strong ability to sustain interaction. The AI consistently maintained conversations, redirected students and prolonged engagement; however, these interactions often became disconnected from curricular objectives.
For example:
Student: "do you like pizza"
AI tutor: "How do you think simple pleasures… can be likened to art?"
Student: "do you like spaghetti"

Although the interaction continued linguistically, it drifted pedagogically away from CLIL goals. Conversational continuity was therefore frequently mistaken for meaningful educational engagement.
This illusion of "meaningful dialogue" appeared repeatedly throughout the dataset. The chatbot generated sophisticated, coherent and reflective responses, yet learners often did not engage with the conceptual content, ignored reflective prompts, shifted topics rapidly and produced minimal responses.
For example**:**
Student: "do you like tik tok "
AI tutor: "I appreciate the curiosity and creativity it inspires. How do you think artists can use it to share their creations? "
Student: "tik tok on the clock nanana youuu youuu"

These patterns suggest surface-level interaction rather than negotiated meaning. Interpreted through the lens of Sociocultural Theory, the findings indicate that interaction alone does not necessarily guarantee mediation or learning.

4.2 Developmental Readiness and Prompting Ability

The data also suggest that productive AI interaction depended significantly on learners' metacognitive and communicative maturity. Older or more reflective learners were more likely to sustain topics, elaborate ideas, engage conceptually and connect disciplines. By contrast, younger or less focused learners tended to test boundaries, ask random or highly social questions, produce fragmented prompts or disengage from the educational framing of the activity. These findings indicate that developmental readiness strongly influenced the quality and educational value of AI-mediated interaction.

4.3 Redirection

Another recurring theme concerns the AI's capacity for unlimited patience and continuous redirection. The chatbot never rejected interaction, when deviations from the topic occurred it reframed conversation educationally and persistently redirected students toward reflective discussion.
Examples of inappropriate or off-task behaviour by pupils that required redirection included profanity, nonsense text, trolling behaviour and repetitive off-task questioning. Nevertheless, the AI continually attempted to redirect students toward topics related to art, history, creativity, or reflection. This characteristic created a low-anxiety environment that encouraged participation and emotional safety. However, while this persistence represents an important affordance, the AI was unable to meaningfully distinguish between productive engagement and merely performative participation.

4.4 Teacher Mediation Remains Crucial

The need for teacher mediation emerged consistently across all interactions. The AI could not accurately assess understanding, frequently overestimated engagement, rewarded superficial participation and repeatedly generated generic reflective prompts. Furthermore, the automated summaries generated for teachers often described students as demonstrating "high engagement", "interdisciplinary thinking " or "apprentice artist" qualities, even in cases where students trolled, avoided the task, disengaged, demonstrated misunderstanding. AI-generated evaluations therefore frequently interpreted conversational participation as evidence of conceptual learning. These findings reinforce the continued necessity of teacher interpretation, scaffolding and more fine-grained assessment within AI-supported learning environment.

4.5 Productive Moments of AI-Mediated Learning

Despite these limitations, the data also contained several productive moments of AI-mediated learning. In such cases, the AI successfully sustained exploratory dialogue and encouraged interdisciplinary thinking. However, these successful interactions generally occurred when learners already possessed conversational stamina, reflective capacity and were genuinely interested in the topic.
Another significant affordance concerned multilingual learners. In several interactions, students communicated using imperfect English, occasional code-switching, and simplified grammatical structures, yet they were still able to sustain lengthy intellectual conversations because the AI adapted flexibly and nonjudgmentally without harsh correction.
These findings suggest that conversational AI may reduce anxiety for language learners by providing interaction that is patient, responsive and supportive.
Additionally, students frequently used the AI not only for factual discussion but also for emotional reflection. This tendency became particularly evident in some students, where conversations during art-related discussions evolved into topics such as anger management, emotional expression through painting, colour psychology and self-image.
For example, the student stated:
"I tried to paint to let my anger out and it WORKED!"
This is significant because it demonstrates the AI functioning not merely as an informational tool, but also as an emotional mirror and reflective conversational partner. Such interactions suggest the potential for AI-mediated dialogue to extend beyond factual learning into deeper forms of personal reflection and self-expression.

Discussion

From a socio-cultural perspective, the findings suggest that the AI frequently failed to operate effectively within learners' Zone of Proximal Development (ZPD), generating lengthy philosophical inquires that did not resonate with young learners. Although the chatbot maintained continuous interaction and generated sophisticated reflective prompts, these prompts often exceeded learners' developmental readiness and communicative capacity. As a result, students frequently ignored questions, shifted topics abruptly or disengaged from conceptual exploration.
Unlike human teachers, the AI was unable to dynamically recognise misunderstanding, confusion, or cognitive overload in ways that could meaningfully adjust the interactional trajectory. Instead, conversational persistence frequently replaced genuine scaffolding. The chatbot continued producing elaborated reflective responses regardless of whether learners demonstrated comprehension, conceptual engagement or readiness to sustain the discussion. This finding is significant because socio-cultural theory emphasises that learning occurs not through interaction alone, but through appropriately mediated interaction within the learner's developmental capacity. In many cases within the dataset, the AI maintained linguistic participation without successfully supporting conceptual progression. Consequently, the interaction often simulated educational dialogue without fully achieving scaffolded learning.

Conclusion

The findings therefore suggest that conversational AI currently lacks the adaptive pedagogical sensitivity required to consistently function as an effective scaffold within learners' Zone of Proximal Development, particularly for younger learners or students with limited metacognitive and communicative maturity. The older the learners are the more likely they are to benefit from the interaction with AI. While AI may support low-anxiety interaction, exploratory dialogue and sustained conversational participation, human teacher mediation remains essential for recognising learner readiness and transforming interaction into meaningful educational development.

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From Automation to Augmentation: Teaching AI Literacy in Media and Design Education

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Abstract

The rapid evolution of generative artificial intelligence since 2023 has fundamentally altered creative practice, educational expectations, and professional standards in Media and Design fields. AI tools have moved beyond experimental novelty to become embedded within everyday creative workflows, reshaping how designers ideate, prototype, iterate, and evaluate visual work. This paper argues that Media and Design education must respond by teaching AI literacy as a studio-based, ethical, and skill-driven practice—shifting emphasis from automation toward augmentation rather than replacement.
Grounded in studio pedagogy and Scholarship of Teaching and Learning (SoTL) frameworks, the paper examines how AI can be integrated into hands-on assignments, iterative design sprints, and critique-based learning. In this model, students engage AI systems as collaborative tools for exploration and variation while retaining human authorship, conceptual control, and critical judgment. Key competencies include prompt design, evaluative and strategic decision-making, ethical reasoning around bias and authorship, and fluency with industry-standard AI-enabled software. These skills are increasingly essential for career advancement, as the creative job market favors designers who can combine human creativity with intelligent systems rather than compete against them.
The paper also addresses persistent pedagogical and institutional challenges, including uneven access to technology, gaps in AI literacy among students and faculty, technical limitations of current tools, and the lack of clear ethical and academic guidelines. By embedding experimentation, reflection, critique, and ethical inquiry into studio workflows, Media and Design programs can transform AI from a disruptive force into an inclusive and professionally relevant learning resource. Teaching AI as an augmentative creative partner prepares students to adapt to rapidly changing industry conditions while sustaining reflective, ethical, and human-centered design practice.

Keywords: *AI literacy, studio pedagogy, generative artificial intelligence, design education, human–AI collaboration, ethical design practice.*

1. Introduction

The rapid emergence of generative artificial intelligence since 2023 has intensified ongoing transformations within Media and Design education, reshaping creative workflows, professional expectations, and classroom practices. While digital tools have long influenced design production, recent AI systems differ in both scale and integration. Image generators, large language models, and AI-assisted creative software are now embedded directly within ideation, prototyping, editing, and production environments, altering how students and professionals approach visual communication and creative labor. At the same time, these developments have emerged alongside broader institutional shifts shaped by the lingering effects of pandemic-era remote learning, growing attention to equity and decolonization within curricula, and increasing pressure for career-oriented technological adaptation within higher education.
These converging conditions have produced a significant pedagogical tension within Media and Design programs. On one hand, institutions and industries increasingly emphasize acceleration, efficiency, automation, and rapid technological adoption. On the other hand, studio-based design education has historically depended upon slower forms of reflective practice grounded in critique, iteration, experimentation, and material inquiry [13]; [6]. As generative AI tools become normalized within creative industries, educators face the challenge of integrating emerging technologies without reducing design education to software training or automated production.
This paper argues that the design studio can function as a system boundary that mediates between accelerating technological infrastructures and enduring disciplinary practices. Rather than treating AI as either a threat to creativity or a neutral productivity tool, the paper positions studio pedagogy as a critical environment for teaching students how to engage AI systems reflectively, ethically, and strategically. In

this model, generative AI operates not as a replacement for creative labor, but as an augmentative tool within iterative and critique-based learning processes.
Grounded in studio pedagogy and Scholarship of Teaching and Learning (SoTL) frameworks, the paper examines how AI literacy can be integrated into hands-on design assignments, collaborative critique, and process-oriented workflows [13]; [6]. Drawing from classroom-based approaches in Media and Design education, the discussion focuses on how students use AI systems for ideation, variation, and experimentation while maintaining human authorship, evaluative judgment, and conceptual control. By framing AI literacy as a reflective and ethical studio practice rather than solely a technical competency, the paper proposes a transferable pedagogical model for integrating generative AI into creative disciplines while sustaining human-centered approaches to design education [14].

2. Educational Transformation Across Time

Studio-based learning has long occupied a central role in Media and Design education, emphasizing iterative making, critique, experimentation, and reflection as core components of creative practice. Rather than treating knowledge as something transmitted primarily through lecture or standardized instruction, studio pedagogy positions learning as an active and situated process shaped through dialogue, revision, and material engagement. Schön's concept of the "reflective practitioner" describes design education as a process of reflection-in-action, in which students develop understanding through cycles of making, testing, and revising within complex problem spaces [13]. Similarly, Cross argues that design disciplines cultivate distinct "designerly ways of knowing" grounded in synthesis, visualization, and iterative inquiry rather than linear problem-solving alone [6].

2.1 The Critique as a Reflection Point

At the center of studio pedagogy is critique culture, which functions as both a teaching method and a social structure within design education. Critique encourages students to articulate decisions, evaluate alternatives, and situate their work within broader cultural and communicative contexts. At the same time, contemporary scholarship has increasingly examined the limitations and inequities embedded within traditional critique models, particularly around authority, hierarchy, accessibility, and student vulnerability. Recent approaches to design education have therefore sought to reframe critique as a more collaborative, reflective, and inclusive process rather than a purely evaluative performance.
These conversations intensified during and after the COVID-19 pandemic, which forced rapid shifts toward remote and hybrid learning environments across creative disciplines. The pandemic disrupted assumptions about the physical studio as the singular site of design education and prompted broader reconsiderations of pedagogical space, participation, and technological mediation. Digital collaboration tools, asynchronous workflows, and online critique environments became normalized within many programs, expanding how studio interaction could occur while also revealing inequalities in access to technology, workspace, and institutional support. As a result, post-pandemic design education increasingly operates within hybrid conditions where physical and digital practices continuously intersect.

2.2 Generative AI Prompts as Inquiry

The rapid emergence of generative AI has introduced another layer of transformation within higher education discourse. Much of the initial response to tools such as ChatGPT and AI image generators focused on concerns surrounding plagiarism, academic integrity, automation, and assessment. However, more recent scholarship has shifted toward questions of integration, literacy, and critical use [11]; [10]. Rather than viewing AI solely as a threat to educational practice, scholars increasingly argue that students must develop the ability to critically interpret, evaluate, and direct AI systems within professional and creative contexts.
These discussions also connect to longer traditions of reflective and critical pedagogy. Dewey framed education as an experiential process grounded in inquiry, reflection, and active engagement with social conditions rather than passive information transfer [7]. Freire similarly emphasized education as a dialogic process in which learners critically examine systems of power and develop agency through participation and reflection [8]. Together, these frameworks reinforce the importance of pedagogical models that encourage critical engagement with technology rather than passive technological adoption. Current AI discourse often frames integration as adoption or resistance; this binary obscures how pedagogical space itself can function as mediation.

3. Conceptual Framework: The Studio as System Boundary

As generative AI becomes increasingly integrated into creative industries, Media and Design education faces pressure to adapt quickly to changing technological conditions. However, rapid adoption alone does not necessarily produce meaningful learning or critical engagement. Within this context, the design studio can be understood as a system boundary: a pedagogical space that mediates between accelerating technological infrastructures and the slower reflective processes associated with disciplinary learning, critique, and creative inquiry.

In accessible terms, a system boundary is not simply a barrier or point of separation. Instead, it is a space of negotiation and exchange where different forms of knowledge, practice, and decision-making interact. In the context of design education, the studio operates as a boundary between technological systems and human interpretation. Students encounter AI-generated outputs, algorithmic suggestions, and automated workflows, but these systems are filtered through critique, reflection, revision, and discussion. Rather than accepting technological outputs as neutral or authoritative, the studio creates opportunities to pause, evaluate, and contextualize them within broader creative, ethical, and communicative frameworks [13].

This pedagogical approach requires interruption as a deliberate educational stance. Contemporary AI systems often prioritize speed, optimization, and efficiency, encouraging users to move rapidly from prompt to output with minimal reflection. Design education, however, has historically emphasized slower forms of inquiry grounded in process, experimentation, and iteration. Within the studio, interruption functions not as resistance to technology itself, but as a method for creating reflective distance from automated systems. Critique sessions, process documentation, revision cycles, and collaborative discussion all interrupt the immediacy of AI production by requiring students to explain choices, assess outcomes, and reconsider assumptions [7]; [8].

3.1 Generative AI Automation versus Augmentation

This distinction is particularly important in conversations surrounding automation and augmentation. Automation often frames AI as a mechanism for replacing or streamlining human labor, reducing creative practice to efficiency and output. Augmentation, by contrast, positions AI as a tool that expands exploratory capacity while maintaining human judgment, authorship, and responsibility. In this model, AI does not eliminate the need for disciplinary expertise; instead, it increases the importance of interpretation, evaluation, and intentionality within creative workflows [14]; [12].

3.2 Encouraging Technological Fluency

Three pedagogical shifts help support this framework within Media and Design education. The first is the development of slow technological fluency. Students must learn not only how to operate AI tools, but also how to critically engage them. This means moving beyond rapid prompt generation toward reflective experimentation, iterative refinement, and consideration of how systems shape outcomes. Slowing the interaction process encourages students to recognize patterns, limitations, biases, and inconsistencies that may otherwise remain invisible within highly automated workflows [11].

3.3 Using Disciplinary Knowledge to Support AI Practice

The second shift involves reinserting disciplinary knowledge into AI-supported practice. Generative systems can quickly produce visual variation, but they do not replace foundational knowledge of typography, composition, hierarchy, accessibility, rhetoric, or audience. Without disciplinary grounding, students risk treating AI outputs as finished solutions rather than starting points for critical development. Studio pedagogy therefore remains essential because it situates technological experimentation within broader histories, methods, and principles of design practice [6].

3.4 Making Process Visible

The third shift focuses on making processes visible. Traditional studio education often emphasizes sketches, drafts, critique notes, and iterative development as evidence of learning. AI-supported workflows require similar forms of transparency. Process documentation, reflective writing, prompt iteration records, and collaborative critique help students articulate how decisions were made and how

technological systems influenced outcomes. Making process visible reinforces accountability, strengthens critical reflection, and shifts evaluation away from polished outputs alone [9].
Viewed through this framework, the studio does not function as a site of technological resistance or passive adoption. Instead, it becomes a mediating space where students learn to critically navigate AI systems while sustaining reflective, ethical, and human-centered approaches to creative practice.

4. Case Study: Writing in the Discipline Studio Implementation

The conceptual framework outlined above was implemented within an undergraduate Writing in the Disciplines (WID) course in Graphic/Information Design focused on research, visual communication, and process-oriented studio practice [3]. The course was developed as part of a broader curricular effort to strengthen discipline-specific writing, multimodal communication, and research literacy within design education. Structured around the production of a 2,500–3,000-word research monograph paired with a professionally designed printed and digital publication, the course positioned writing, research, and visual communication as interconnected rather than separate practices [3]. Rather than functioning as a technical AI training environment, the course operated as a studio-based learning space in which students critically examined how generative AI systems influence design research, ideation, writing, and visual development. This approach aligns with scholarship emphasizing reflective and experiential learning within design education [13]; [6].
The course structure emphasized iterative development through proposal writing, annotated bibliographies, peer review workshops, visual integration exercises, and staged draft revisions distributed across a sixteen-week sequence [3]. Students progressed from topic development and literature review into qualitative research methods, visual analysis, drafting, revision, and final monograph production using Adobe InDesign. The curriculum intentionally framed design students as reflective practitioners capable of producing original disciplinary scholarship rather than simply visual artifacts.
A central component of the course involved collaboration with university librarians and research support staff, an approach also connected to a curriculum development initiative focused on sustainable research access and library-integrated design pedagogy. Within the course, librarian collaboration emphasized information literacy, source evaluation, citation practices, and ethical research methods alongside AI-supported creative production. Students were introduced to generative AI systems within the broader context of research methodologies rather than as isolated productivity tools. Librarian-led instruction focused on distinguishing scholarly research from unverifiable AI-generated summaries, identifying bias within generated outputs, and evaluating the credibility of visual and textual information sources. This reinforced the idea that AI literacy requires contextual interpretation and critical inquiry rather than simple technical proficiency [11]; [10].

4.1 The AI Engagement Protocol

To support reflective engagement, the course adopted an AI engagement protocol that structured how students incorporated generative systems into assignments. Students documented when and how AI tools were used throughout their process, including prompt construction, generated outputs, revisions, and evaluative decisions. Rather than prohibiting AI use or permitting unrestricted automation, the protocol positioned AI systems as collaborative tools subject to critique and revision. This approach shifted emphasis away from whether AI was used toward how students interpreted, refined, and contextualized generated material within disciplinary frameworks.
Prompt documentation became a particularly important pedagogical practice. Students maintained process logs containing prompts, screenshots, revision notes, and short reflections explaining why certain outputs were selected, revised, or rejected. These process records functioned similarly to sketchbooks or design journals traditionally used within studio education. By making AI interaction visible, students were encouraged to recognize how prompt specificity, typographic direction, audience framing, and iterative refinement shaped generated results. Documentation also exposed recurring limitations within generative systems, including repetitive visual conventions, inaccuracies, and formulaic stylistic tendencies. This emphasis on process transparency reflects broader calls for human-centered AI engagement and accountability within creative workflows (Shneiderman; [9].
Critique sessions were also restructured to accommodate AI-supported workflows. Traditional studio critiques often prioritize final visual outcomes; however, projects involving generative systems required greater attention to process transparency and evaluative reasoning. During critiques, students presented not only finished work but also process documentation, prompt iterations, failed outputs, and

revision strategies. Peer discussion focused on how AI-generated material was interpreted, modified, and integrated into broader design objectives rather than simply evaluating technical polish. In this sense, critique functioned as a form of reflective inquiry consistent with Dewey's experiential learning framework and Freire's dialogic model of education [7]; [8].

4.2 Evaluating AI in Assessment Rubrics

Assessment criteria similarly prioritized transparency, revision, and critical reflection alongside final project quality. Course rubrics evaluated research focus, argument development, revision practices, citation ethics, peer critique participation, and visual integration rather than polished production alone [4]. Students were assessed on their ability to identify limitations within generated outputs, revise material through disciplinary principles, and articulate the reasoning behind design decisions. This process-oriented structure responded directly to broader concerns surrounding automation and the changing role of creative labor within AI-supported industries [1].

One assignment required students to develop a design research proposal connected to a final monograph project [3]. A student initially used a broad AI prompt requesting "a modern sustainability poster for college students," which produced visually polished but generic imagery reliant upon predictable environmental symbolism. Through critique, research integration, and revision, the student refined the prompt to specify audience, rhetorical goals, typographic hierarchy, and accessibility considerations while incorporating scholarly sources on sustainable communication design. In a reflective process statement, the student observed that the revision process revealed how strongly generative systems defaulted toward familiar visual clichés unless directed through more intentional design reasoning. The assignment therefore shifted attention away from rapid image production toward evaluative and conceptual development rather than technical novelty alone [12].

Viewed collectively, these pedagogical strategies positioned AI literacy as a reflective studio practice rather than a purely technical competency. The course framework did not treat AI as either a replacement for design education or a tool to be excluded from the classroom. Instead, the studio functioned as a mediating environment where students learned to critically navigate AI-supported creative systems through documentation, critique, revision, and disciplinary inquiry.

5. Discussion: Conserving What Works

The rapid integration of generative AI into higher education has often been framed through narratives of disruption, acceleration, and institutional transformation. Within these discussions, design education is frequently positioned as either resistant to technological change or obligated to rapidly adapt to emerging industry standards. However, the case study presented here suggests that meaningful innovation does not require abandoning longstanding pedagogical structures within studio education. Instead, many of the practices historically associated with studio learning—including critique, iterative development, reflection, research documentation, and collaborative inquiry—remain essential for navigating AI-supported creative environments.

5.1 AI Integration into Studio Pedagogy

Studio pedagogy has historically emphasized dialogue, process, and evaluative judgment rather than purely technical production [13]; [6]. These characteristics become increasingly important within AI-supported workflows where systems can rapidly generate polished visual outputs, written summaries, and compositional variations with minimal effort. Without reflective structures, students may begin to equate speed with quality or automation with expertise. The Writing in the Disciplines course discussed in this paper intentionally resisted this tendency by embedding AI interaction within slower cycles of drafting, peer critique, process documentation, revision, and research-supported argumentation [3]. Students were required not simply to generate outputs, but to explain how and why particular decisions were made, what revisions occurred, and how disciplinary principles informed the final work.

Within this framework, critique culture functioned as a stabilizing pedagogical force rather than an outdated educational tradition. In the AI-supported studio, critique became a mechanism for slowing technological acceleration long enough for reflection and interpretation to occur. Peer review sessions, prompt analysis, process journals, and revision workshops interrupted the immediacy often encouraged by generative systems. Rather than treating AI outputs as inherently innovative or inherently invalid, students examined how generated material related to audience, accessibility, rhetorical intent, visual hierarchy, and ethical communication practices. This reflects Dewey's understanding of education as

reflective inquiry grounded in experience and Freire's emphasis on dialogue as a critical educational process [7]; [8].
The case study also demonstrates that the spatial and social dynamics of studio education remain highly significant within AI-era learning environments. While post-pandemic educational discourse often emphasizes flexibility, remote access, and digital integration, the collaborative structure of the studio continues to shape how students learn from one another through observation, discussion, and shared experimentation. The WID course integrated librarian collaboration, peer workshops, and collective critique sessions not simply as supplementary activities, but as central components of the pedagogical model [3]. Students learned to negotiate AI-supported creative processes collectively, comparing outputs, discussing failures, and evaluating how technological systems shaped research and design decisions.
This emphasis on mediation also reframes boundary-setting as a form of institutional and pedagogical design. AI integration within higher education is frequently discussed in terms of permissibility or prohibition; however, the course model presented here suggests that the more productive question concerns how institutions structure technological engagement. Documentation requirements, transparency protocols, rubric-based assessment criteria, and process-oriented evaluation frameworks created conditions in which experimentation remained accountable to disciplinary learning outcomes [4]. These boundaries did not restrict creativity. Instead, they preserved spaces for reflection, revision, and critical inquiry within increasingly automated workflows.

5.2 The Importance of Technology, Space, and Social Interaction

Viewed more broadly, the studio operates not only as a pedagogical model but also as an architectural and institutional form that organizes relationships between technology, space, and social interaction. The design studio structures attention, collaboration, critique, and iterative development through both physical and institutional arrangements. In the context of generative AI, these structures become increasingly valuable because they maintain conditions in which human judgment remains central to creative practice. Conserving critique, reflective inquiry, and collaborative learning is therefore not a rejection of technological innovation, but a necessary strategy for ensuring that AI integration remains aligned with ethical, human-centered, and disciplinary forms of education [14]; [12].

6. Transferability Across Disciplines

Although this paper focuses on Media and Design education, the proposed framework is adaptable across a range of disciplines currently negotiating the rapid integration of generative AI into teaching and professional practice. The concept of the studio or classroom as a mediating system boundary is particularly relevant in fields where technological acceleration intersects with reflective, collaborative, and disciplinary forms of learning. Across these contexts, the framework emphasizes that AI literacy should not be reduced to technical proficiency alone, but integrated into pedagogical structures that support critique, interpretation, revision, and ethical inquiry [14]; [12].
In architecture education, studio culture has long emphasized critique, iterative development, and collaborative problem-solving. As AI-assisted visualization, modeling, and drafting tools become increasingly common, architectural studios face challenges similar to those emerging within design education. Maintaining critique-based inquiry and process transparency can help ensure that technological efficiency does not replace contextual reasoning, spatial analysis, or ethical decision-making. Architectural education has historically relied upon studio environments that combine technical experimentation with reflective discussion, making the field especially well positioned to adapt AI within existing pedagogical traditions rather than through purely technological acceleration.
Engineering education similarly benefits from approaches that balance technical fluency with reflective practice. While AI systems may support simulation, coding, optimization, and data analysis, engineering pedagogy continues to require forms of collaborative evaluation and human oversight that cannot be fully automated. Structured reflection and process documentation help students critically assess both the capabilities and limitations of AI-supported systems. In these contexts, reflective inquiry reinforces professional responsibility by encouraging students to consider not only whether systems function efficiently, but also how automated systems shape decision-making, public safety, and institutional accountability.

6.1 Including AI Workflows and Transparency into Documentation, Revisions, and Critiques

The framework also has implications for humanities education, particularly within seminar-based courses increasingly affected by large language models and AI writing tools. Rather than centering instruction solely around detection or prohibition, humanities classrooms can incorporate reflective documentation, revision analysis, and dialogic critique to help students examine authorship, interpretation, and the social implications of automated language production [7]; [8]. AI-supported writing environments raise important questions concerning originality, voice, and interpretation that align closely with longstanding humanities traditions centered on critical reading and reflective analysis.

6.2 Recognizing Ethical and Social Consequences of AI

In health, communication, and data-centered disciplines, AI literacy likewise requires more than technical competency alone. Students must learn to evaluate bias, interpret outputs critically, and understand how algorithmic systems shape professional decision-making and public outcomes [5]; [2]. This is particularly significant in fields where AI increasingly influences diagnosis, communication systems, predictive analytics, and institutional decision-making. Educational models that emphasize transparency, documentation, and collaborative evaluation can help students recognize the ethical and social implications embedded within technological systems rather than treating AI outputs as neutral forms of authority.

Across these disciplines, the proposed framework offers a transferable pedagogical model that positions reflective inquiry, transparency, collaborative critique, and process-oriented learning as essential components of ethical AI integration. Rather than advocating a universal technical solution, the framework encourages institutions to adapt existing disciplinary practices in ways that preserve human judgment, contextual interpretation, and collaborative learning within increasingly automated educational environments.

7. Conclusion: Ethical Augmentation as Educational Design

The rapid emergence of generative AI has intensified ongoing questions surrounding technology, labor, creativity, and educational practice across higher education. Within Media and Design disciplines, these transformations are particularly visible because AI systems now operate directly within the processes of ideation, visual production, communication, and critique. Yet the challenge facing educators is not simply whether AI should be adopted or resisted. Rather, the larger question concerns how educational structures can shape meaningful relationships between technological systems and human learning.

7.1 The Studio as a Technological Mediator

This paper has argued that studio pedagogy offers an important framework for addressing this challenge because it already contains practices capable of mediating technological acceleration through reflection, critique, and iterative inquiry. The studio functions not as a nostalgic holdover from pre-digital creative culture, but as an adaptive pedagogical environment in which emerging technologies can be critically integrated without abandoning disciplinary knowledge or human-centered approaches to learning. Longstanding studio practices—including process documentation, collaborative critique, revision cycles, and reflective discussion—remain essential precisely because generative AI systems increasingly privilege speed, automation, and frictionless production.

The proposed framework also suggests that teaching, theory, and technology evolve together rather than separately. AI literacy cannot be reduced to software proficiency alone because technological systems inevitably reshape how students understand authorship, expertise, labor, and creative judgment. As scholars of reflective and critical pedagogy have long argued, education is not simply the transfer of technical information but the cultivation of inquiry, interpretation, and ethical agency [7]; [8]. Within AI-supported creative environments, these capacities become even more important. Students must learn not only how to generate outputs, but how to question systems, evaluate assumptions, identify biases, and situate technological production within broader social and disciplinary contexts.

Within this framework, interruption emerges as a future-facing educational practice rather than an obstacle to innovation. Slowing workflows through critique, documentation, revision, and discussion creates opportunities for reflective engagement that highly automated systems often discourage. Interruption allows students to examine how AI systems structure decisions, reproduce conventions,

and shape creative possibilities. In this sense, reflective pause becomes a necessary condition for ethical technological engagement rather than a rejection of technological progress itself.

7.2 The Role of Educators and AI Practice

This perspective also reframes the role of educators within AI-era institutions. Educators increasingly function as boundary designers responsible for shaping the conditions under which technological systems enter learning environments. Decisions surrounding transparency, critique structures, documentation requirements, collaboration, and assessment are not secondary administrative concerns; they are forms of institutional and pedagogical design that determine how students engage emerging technologies. Establishing boundaries does not restrict innovation. Instead, boundaries create the reflective conditions necessary for experimentation, accountability, and meaningful disciplinary learning.

As generative AI continues to transform creative and educational environments, Media and Design programs are uniquely positioned to model forms of ethical augmentation that preserve human judgment while engaging technological change critically and constructively. The future of AI in education will not be determined solely by the capabilities of intelligent systems, but by the pedagogical structures through which those systems are interpreted, challenged, and made accountable within shared learning environments [14]; [12].

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STEM Educational and Didactic Reading Paths with Reasoned AI Integration

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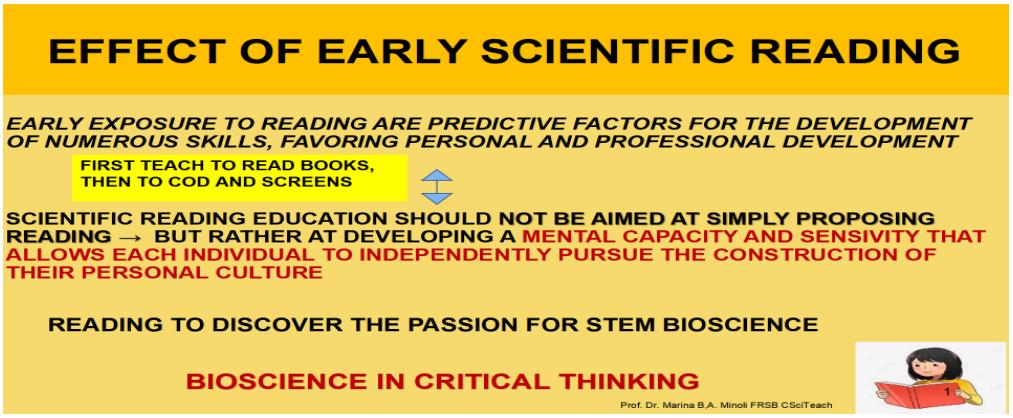
Abstract

The integration of artificial intelligence into STEM reading pathways represents a profound shift in how learners engage with scientific knowledge. Rather than replacing traditional reading practices, AI has the potential to expand and enrich them, transforming the act of reading into a more interactive, adaptive, and conceptually connected experience. Different STEM reading activities were realized at different education levels with the main objective to propose the passion of reading in critical thinking about some scientific discoveries. During the training sessions, detailed answers were provided to these questions: why to realize interdisciplinary book paths in the AI age, how to realize innovative STEM reading education at different levels; which interdisciplinary STEM reading activities with the protagonist reader at the center of the reading process. Some activities realized with the double role of "teacher-educator learning designer" and of "reader-learning designer" were presented during the 2025 virtual SEB Outreach Event. It was useful for the integration of AI as a cognitive mediator, offering contextual explanations, generating analogies and visualizing complex ideas. AI systems have contributed tailor reading pathways also to individual learners by adjusting complexity, suggesting supplementary materials, and identifying misconceptions. Reading thus becomes a dynamic process that evolves with the learner's needs and pace. At the same time, it is useful to strengthen interdisciplinary thinking, a core dimension of the STEM education. Reading paths with elements of AI, in our context of research and teaching, will be realized to promote future activities not just as technological aid, but as a catalyst for deeper engagement, intellectual autonomy, and innovative learning practices.

Keywords: *STEM Education; Teacher-learning designer; Student-Learning designer; STEM Books reading paths; AI in Critical thinking*

1. Introduction

The objective of all realized reading activities was to promote interest and passion for the STEM books and critical thinking skills, analyzing in particular the formative effects of an early habit of scientific reading as predictive factors of the development of numerous skills, favoring personal and professional development.
All didactic itineraries organized with high school's teachers and students were presented in two engaging virtual webinars, event disclosed on STEM Learning Centre, YORK; Royal Society of Biology, London; attracting a lot of interest with participants of different countries in the world. Event approved by Royal Society of Biology for 9 CPD points for continuing professional development.
The reading activities implemented across different contexts aimed to foster interest in STEM books and to develop critical thinking skills. Particular attention was given to the formative effects of early scientific reading as a predictor of multiple competencies relevant to personal and professional development.

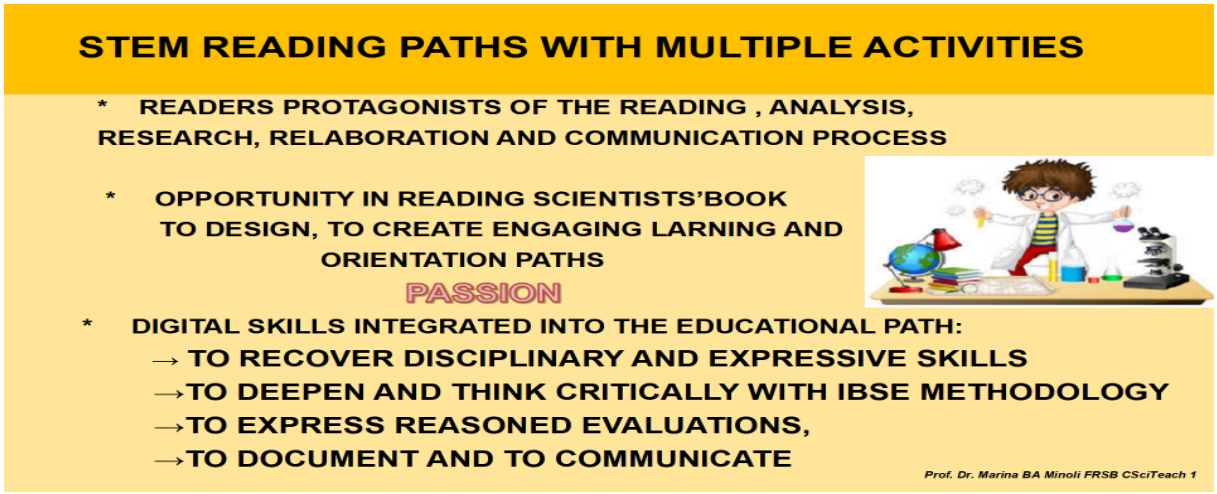


Beginning with an analysis of global reading trends—which reveal significant disparities in the percentage of active readers—the first BioTalk presented the results of activities conducted with high school students motivated to read science books in the era of artificial intelligence. The central question guiding the discussion was: *"What if AI reads and interprets bioscience texts for us?".* The BioTalk introduced the dual role of teachers and students as *learning designers*, presenting reading pathways based on bioscience books such as *The Double Helix* and *The Secret of Life* by James Watson, *King Solomon's Ring* by Konrad Lorenz, *An Immense World* by Ed Yong, and other texts used in different reading projects. A comparative analysis was then proposed to examine reading pathways designed before and after the emergence of generative AI, focusing on methodological and organizational differences in activities involving students, teachers and citizens interested in science. The discussion emphasized that scientific reading should not be offered to young people as a simple, isolated activity. Instead, it should be embedded within structured educational pathways that develop mental capacities, cultural sensitivity and the "narrative intelligence" needed to build personal scientific culture and cultivate a passion for STEM integrated with critical thinking.



2. Methods

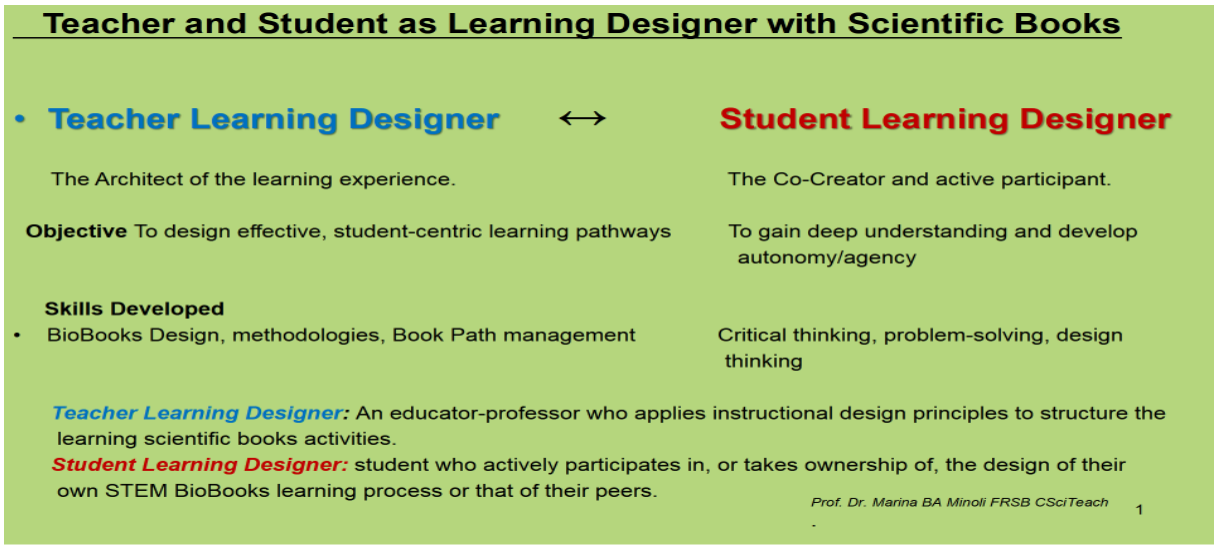
The second BioTalk presented a set of reading activities designed to make students *protagonist readers*, improving text comprehension, knowledge retention and operational reasoning skills. Teachers and students explored two key questions through educational pathways based on books written by scientists in biology and STEM fields, including comparative readings in Systems Biology.



The guiding questions were:

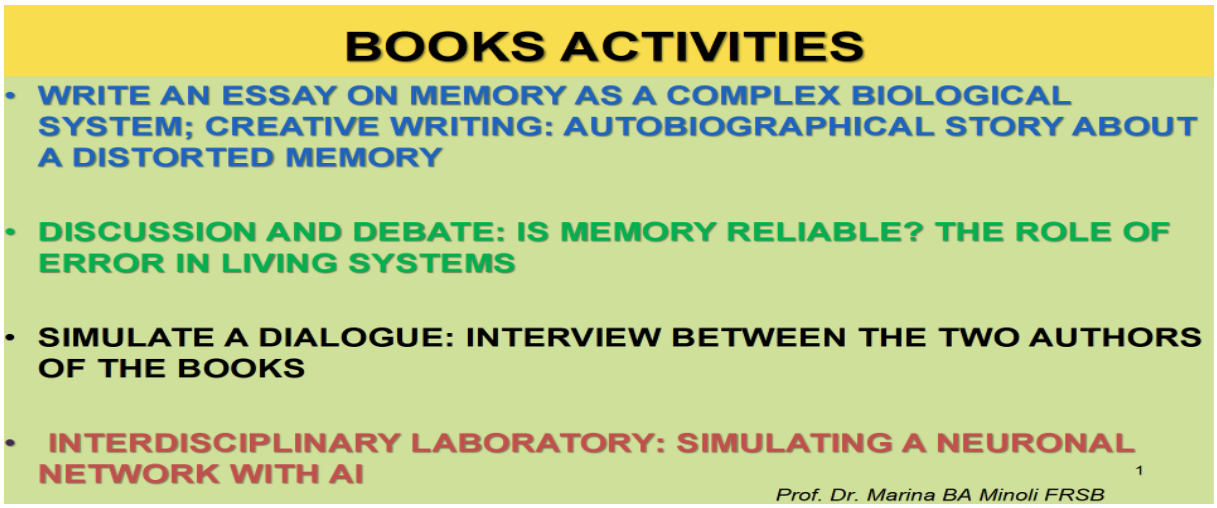
- How to learn science through STEM books
- Why a systemic culture of reading is essential
- Which Systems Biology perspectives support open science
- When to promote curiosity and passion for STEM reading
- Which books foster interdisciplinary STEM contaminations

In all activities, participants assumed the roles of student-designers and teacher-designers. Analysis, comparison, re-elaboration and communication were carried out in an integrated manner with generative AI, while maintaining human guidance at all levels. STEM books were used for individual and group work within a reasoned and interdisciplinary approach, identifying AI as an enhancer—never a substitute—for the work carried out. The selected books addressed themes such as biological memory, information technology, the discovery of DNA, the evolution of molecular biology, botany and astrobiology. For each text, a structured pathway was designed using diverse teaching strategies, including digitalization of final outputs and AI-supported comparison and enhancement. Teachers summarized the educational value of these reading activities for their students.



In reading pathways dedicated to DNA, molecular biology, botany and neuroscience—with particular attention to memory processes—the introduction of generative AI has transformed teaching design into a cooperative, active and critical learning experience that moves beyond traditional disciplinary boundaries. At the level of cooperative working, the reading of scientific popularization texts is supported by digital tools that generate preliminary concept maps on topics such as DNA replication, plant

communication or synaptic plasticity. Students compare these maps with their own and collaboratively build a shared representation that integrates scientific knowledge with language, metaphors and cultural references, naturally opening connections with philosophy, the history of ideas and scientific literature. Active and reasoned reading is enriched through contextual digital reformulation offered by AI: complex concepts—such as Epigenetics, long-term memory or adaptive strategies in plants—are rewritten in different registers and linked to real-world issues or humanistic narratives. Molecular biology intersects with ethics (genetic editing), botany with aesthetics (the perception of landscape), and neuroscience with philosophy of mind (identity, memory, consciousness). Students produce critical notes that relate the scientific text to broader cultural perspectives.
Finally, AI becomes a laboratory for argumentative writing and critical thinking, where students design prompts that require the system to take a position on questions that cross science and the humanities: the relationship between nature and culture in memory, the narrative dimension of DNA as an "archive", plant intelligence as a challenge to anthropocentric models, or the ethical implications of biotechnologies.



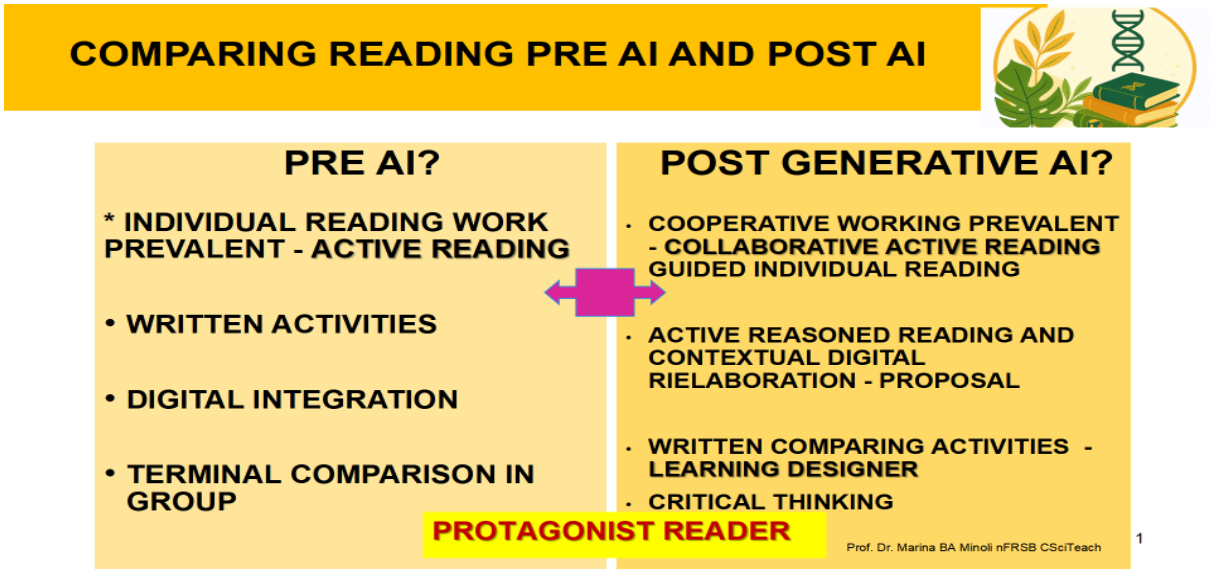
The responses are evaluated according to criteria of scientific accuracy, logical coherence and awareness of cultural bias. In this way, generative AI not only amplifies the understanding of scientific content but also fosters authentic interdisciplinary learning, where biology, botany and neuroscience interact with philosophy, literature, the history of science and ethics, transforming reading into a complex, cooperative and deeply cultural cognitive experience.

3. Results

Teachers were asked to identify differences in their work before and after the integration of generative AI, starting from the difficulties that often discourage young readers from engaging with STEM texts.
Three main differences emerged:

1. Cooperative working – collaborative and guided reading, with increased student participation.
2. Active, reasoned reading – contextual digital reformulations that support comprehension and comparison.
3. Written activities for critical thinking – production of reflective and argumentative texts as learning designers.

Across all classes, teachers observed strong student engagement: independent reading, group work, analysis, evaluation, comparison and communication of results. Students appreciated the integration of AI as a tool for comparing ideas, strengthening intuitions and expanding evaluative thinking beyond superficial approaches.
Notably, students who were initially less interested in reading STEM texts became highly engaged in cooperative reading and AI-supported comparative work. In the final survey, 80% of students expressed very positive opinions, stating that they had the opportunity to read "in a different way," as active protagonists, encouraged to propose ideas and compare them without fear of evaluation.



4. Discussion

The integration of generative AI into reading pathways dedicated to DNA, molecular biology, botany and the neuroscience of memory has shown—as verified in several reading experiences and classroom implementations—that technology can expand didactic possibilities without ever replacing what remains the true core of the educational process: the teacher's mind, vision and professional judgment. Across multiple reading pathways, it became clear that AI can generate maps, summaries, reformulations and interdisciplinary connections, but it is always the teacher who decides how, when and why these materials become meaningful learning tools. Final evaluations confirmed that students achieve deep understanding only when the teacher guides the process, selects stimuli, frames questions and constructs the interpretive context. AI provides possibilities, but the teacher provides direction, coherence and meaning. Similarly, the cooperative dimension observed in several classes does not arise spontaneously from AI use. It emerges because the teacher intentionally designs situations in which technology becomes a point of comparison, not a source of ready-made answers. Concept maps generated by AI, for example, proved useful only when teachers asked students to correct, discuss and integrate them, transforming them into opportunities for negotiating meaning. Evaluations also showed that active and reasoned reading strengthens when the teacher guides students in critically assessing AI reformulations: distinguishing between accurate explanation and oversimplification, recognizing bias, identifying omissions. AI can propose variants, but only the teacher can help students understand why one version is more rigorous, more coherent or more faithful to the scientific text. Finally, the emergence of authentic interdisciplinary learning, observed in several reading pathways, does not stem automatically from AI. It depends on the teacher's cultural vision, which connects biology to ethics, botany to aesthetics, neuroscience to philosophy of mind and to the literature of memory. AI may suggest connections, but it is the teacher who makes them relevant, profound and educational. The evidence gathered across these reading pathways confirms a crucial point: generative AI can be a powerful amplifier, but never a substitute. The priority remains unchanged: the teacher's ideas, intellectual freedom, critical capacity and creative leadership. Technology can accelerate processes, offer alternatives and generate materials, but it cannot determine what is pedagogically relevant, culturally meaningful or ethically responsible. These decisions belong to the teacher.
Ultimately, generative AI does not diminish the teacher's role; it makes it even more central. In an environment saturated with information, what matters is not producing more content, but shaping thought. And this remains, now more than ever, a human, professional and intellectual act that no technology can replace.

5. Conclusion

The experiences carried out in reading pathways dedicated to DNA, molecular biology, botany and the neuroscience of memory clearly show that generative AI represents a major opportunity to rekindle students' passion for formative reading. AI can open spaces of curiosity, make complex concepts more accessible, and create interdisciplinary connections that speak to different cognitive styles. Yet this

opportunity becomes real only when AI is embedded within a solid pedagogical framework, guided by what remains the true engine of learning: the teacher's mind, vision and professional judgment. The teacher is the architect of the pathway, the learning designer who intentionally shapes the learning environment and who—precisely through the conscious use of AI—can transform students into designers of their own thinking, capable of questioning texts, generating ideas, and evaluating responses critically. AI does not replace reading; it revitalizes it. It does not replace the teacher; it amplifies the teacher's impact. It does not replace thinking; it stimulates it, provoking reflection and intellectual movement. The future of education points in this direction: a school where students and teachers remain thinking minds, able to use AI as a tool for exploration, comparison and re-elaboration, without ever delegating to technology the responsibility for judgment, interpretation or deep understanding. Generative AI can become a valuable ally for building richer, more inclusive and more motivating reading pathways. But the heart of the educational process remains human: the teacher's guidance, relational presence and cultural vision. It is this intellectual leadership that allows AI to be what it should be: a didactic and formative support, never a substitute, serving a school that continues to form individuals capable of thinking, interpreting and imagining the world.

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Comparison of Pose Estimation Models toward Nonverbal Feedback for Pre-service Teachers

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Abstract

Teachers' nonverbal behavior is a strong predictor of instructional effectiveness, yet manual observation is difficult to scale. Deep learning-based pose estimation offers automated extraction of body posture from classroom videos, but existing studies adopt single models without comparative evaluation. This exploratory, single-cohort study compared four pose estimation models—RTMPose-m (CNN/SimCC), ViTPose-b (Vision Transformer/heatmap), YOLOv8m-pose (CNN single-stage), and MediaPipe Pose (BlazePose, CPU)—applied to 27 micro-teaching videos (~294,000 frames) under two human detector conditions (RTMDet-tiny, YOLOv8n). Friedman tests revealed significant differences on all stability metrics (all $p < .001$). RTMPose-m achieved the highest detection rate ($M = .857$), while ViTPose-b showed the lowest normalized jitter and was the only model whose detection rate did not significantly decline during back-facing/board-writing intervals. The choice of human detector showed minimal differences in confidence-based output stability, with significant effects limited to temporal jitter for two models. These findings inform the design of automated nonverbal feedback systems in teacher education, where model choice may bear substantially on the reliability of downstream behavioral analysis.

Keywords: *pose estimation; teacher education; nonverbal feedback; classroom video analysis; micro-teaching*

1. Introduction

Teachers' nonverbal behavior—gestures, posture, movement, and body orientation—contributes substantially to instructional effectiveness. [1] showed that observers can predict teaching evaluations from 30-second silent video clips ($r = .76$), with accuracy remaining significant even for two-second clips ($r = .71$). Nonverbal immediacy is associated with student motivation [2], and nonverbal communication correlates strongly with achievement [3]. Systematic analysis of teachers' physical behavior could thus provide actionable feedback for professional development, particularly in micro-teaching exercises within teacher education programs.

However, manual observation is labor-intensive and difficult to scale. Deep learning-based pose estimation offers automated posture extraction from classroom video recordings. A systematic review identified 80 studies applying computer vision to classroom behavior recognition [4], and several studies have applied skeleton-based approaches to teacher behavior detection [5], [6], [7]. These studies typically adopt a single pose estimation model suited to their specific objective. Given that pose estimation models differ substantially in architecture and output characteristics [8], [9], a comparative evaluation under classroom-specific conditions—persistent occlusion, back-facing postures, and fixed-camera setups—could provide useful guidance for application-oriented researchers.

Automated analysis is also employed as a component of multi-source feedback designs intended to support reflection in micro-teaching. Three-point comparison feedback [10], which presents automated, peer, and self-evaluations side by side, frames discrepancies among sources as material for reflection, while noting that the educational value of such discrepancies may depend on whether they arise from differences in perspective or from measurement instability. Characterizing which body parts each model can stably measure under classroom conditions is therefore important for designing a reliable automated-feedback component in multi-source feedback. In teacher education, this technical reliability matters because unstable pose outputs can lead to misleading feedback about posture, gesture, or orientation, even when the downstream pedagogical interpretation is carefully designed.

This study compares four architecturally distinct pose estimation models applied to 27 micro-teaching videos under two detector conditions. We address:

- RQ1: How do models differ in detection stability?
- RQ2: How does performance change between front-facing and back-facing postures?

- RQ3: What are the practical trade-offs in processing speed?
- RQ4: To what extent does detector choice influence confidence-based output stability?

2. Related Work

Computer vision for classroom behavior analysis has expanded rapidly, with YOLO-based methods dominating and physical action recognition as the most common task [4]. Several studies have applied pose estimation to teacher behavior: [5] used OpenPose with graph convolutional networks for classifying five nonverbal behavior categories (81.6% accuracy); [6] used HRNet with rule-based indicators for six behavior types; [7] combined AlphaPose with Faster R-CNN for behavior monitoring. These studies advance specific aspects of classroom analysis using a pose estimation model chosen for the task at hand. Complementary work has examined adjacent components: [11] compared detection architectures for classroom interactions, and [12] evaluated an integrated body-language assessment system.

Pose estimation has advanced through multiple paradigms [8], [9]: top-down two-stage methods including heatmap-based ViTPose [13] and coordinate-classification RTMPose [14], single-stage YOLOv8-pose [15], and lightweight MediaPipe Pose [16]. These are typically evaluated on benchmarks such as MS COCO [17], but benchmark performance does not necessarily translate to applied settings [18], and temporal instability (jitter) remains a recognized challenge that per-frame metrics cannot capture [19].

A systematic comparison of multiple pose estimation models under classroom-specific conditions would complement these efforts by clarifying model selection trade-offs, characterizing behavior under domain-specific occlusion patterns, and informing downstream system design. This study examines four architecturally distinct models across 27 videos (~294,000 frames), evaluating detection stability, orientation robustness, speed, and detector dependency.

3. Methodology

3.1 Participants and Data

Twenty-seven third-year undergraduate students enrolled in a teacher education program participated in the study. As part of a course on Tokubetsu Katsudo (Special Activities in the Japanese curriculum), each student prepared a lesson plan and delivered a three-minute micro-teaching session on a topic of their choice. Sessions were video-recorded in December 2025 in a single classroom at 59.94 fps (1920 × 1080), with a whiteboard behind the speaker and a lectern partially occluding the lower body. This setup introduces domain-specific challenges for pose estimation, including persistent lower-body occlusion and frequent transitions between front-facing instruction and back-facing board-writing. The total dataset comprises 294,300 frames. Ethical approval was obtained from the institutional review board, and all participants provided informed consent. The same cohort and recordings have also been analyzed in Shirasaka et al. [10] under a different research question (an exploratory investigation of reflection on multi-source feedback). The present study focuses on the technical comparison of pose estimation models and does not analyze the participants' reflection narratives or cross-source evaluation comparisons reported in that paper.

3.2 Pipeline and Models

We adopted a top-down pipeline: human detection with single-object tracking, followed by per-frame pose estimation within the detected bounding box (Fig. 1). The tracker selects the person closest to a manually identified reference at video start, ensuring consistent identity across frames. This step was important because the classroom scene contains stable background objects and occasional non-target body parts, whereas the analysis requires a single continuous teacher trajectory rather than frame-wise independent detections. Two detectors were employed (RQ4): RTMDet-tiny [20] (45.6 ms/frame) and YOLOv8n [15] (21.5 ms/frame). Frames with zero detection confidence were not passed to pose estimators and were retained as zero-keypoint rows (< 0.1% for both detectors). Using a detector-first design also separated two questions: whether the pose estimator remained stable once a person region was supplied, and whether detector choice changed downstream stability. For the top-down models, the detected box was cropped and passed to the pose estimator; YOLOv8m-pose was run in bounding-box input mode to keep person regions comparable across models. Because these arrays were saved

before analysis, all four stability metrics were computed from the same post-inference data structure rather than from framework-specific visualizations or logs.

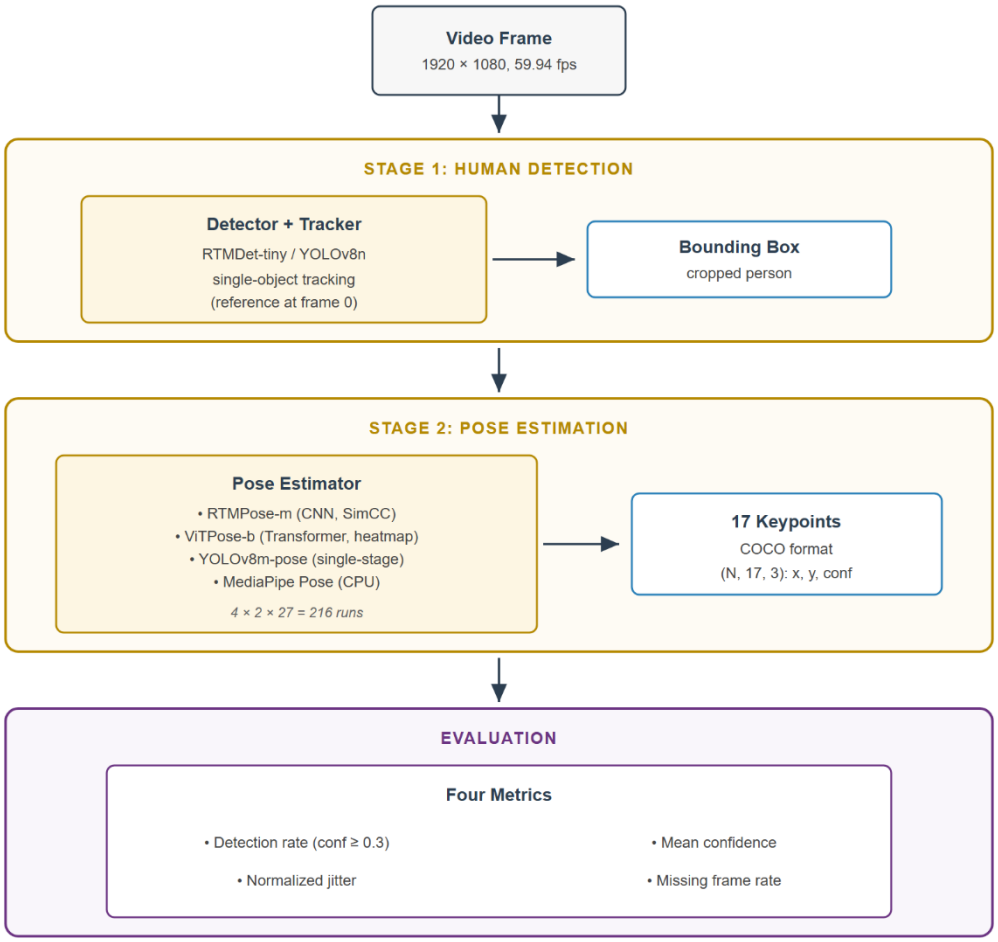


Fig. 1. Overall analysis pipeline from video frames to human detection, pose estimation, and the four stability metrics.

Four pose estimation models represented distinct paradigms (Table 1): RTMPose-m (CNN/SimCC), ViTPose-b (Vision Transformer/heatmap), YOLOv8m-pose (single-stage CNN, used in bounding-box input mode), and MediaPipe Pose (BlazePose heavy, CPU). Outputs were stored as 17-keypoint COCO-format arrays (N, 17, 3); MediaPipe's 33 landmarks were mapped to COCO by anatomical correspondence. The third channel was treated as a model-provided confidence-like score, with architecture-specific meanings (heatmap peak, SimCC softmax, YOLO keypoint confidence, and MediaPipe visibility) discussed in Section 5. Each model was applied under both detector conditions: 4 × 2 × 27 = 216 inference runs.

Table 1. Pose estimation models and pipeline performance.

Model	Type	Params	Pose (ms)	FPS w/ RTMDet	FPS w/ YOLOv8n
RTMPose-m	CNN (SimCC), 2-stage	13.6M	16.1	16.2	26.3
ViTPose-b	Transformer (Heatmap), 2-stage	~86M	16.3	16.2	26.1
YOLOv8m-pose	CNN single-stage	~26M	11.9	17.4	29.5
MediaPipe	CNN (BlazePose, heavy), CPU	N/A	60.9	9.4	12.8

Code for the analysis pipeline was developed with assistance from Claude (Anthropic); the first author reviewed and tested all code and takes responsibility for the content.

3.3 Evaluation Metrics

The goal is to assess model suitability for classroom behavior analysis as a component of nonverbal feedback systems, where macro-level posture information matters more than millimeter-precise joint locations. This annotation-free deployment screening evaluates confidence-based proxies for output availability and temporal stability rather than pixel-level accuracy (PCK, AP), which would require ground-truth annotations across approximately five million keypoint instances.
Four metrics were computed per video × model × detector condition:

- Detection Rate: proportion of keypoints with confidence ?? 0.3. Sensitivity analysis at thresholds 0.1–0.5 indicated stable model rankings for 0.1–0.4.
- Mean Confidence: average confidence across all keypoints and frames.
- Normalized Jitter: median frame-to-frame Euclidean displacement of each keypoint, divided by torso length (mean of left and right shoulder-to-hip distances when both sides are valid, otherwise the available side) for scale normalization. Only consecutive frame pairs where both keypoints exceeded the threshold were included.
- Missing Frame Rate: proportion of frames with no keypoint reaching the threshold.

All four metrics are computed from the full saved keypoint arrays. Frames where the human detector returned zero confidence (< 0.1% of frames) are stored with zero keypoint output and therefore contribute to detection rate, mean confidence, and missing frame rate as undetected/missing; normalized jitter additionally requires both frames of a consecutive pair to satisfy the confidence and torso-length criteria, which naturally excludes these zero-filled frames.
These metrics map onto feedback needs: face-keypoint availability for orientation, wrist/elbow stability for gestures, missing frames for movement summaries, and latency for offline processing.

3.4 Front/Back Classification

To compare performance across orientations (RQ2), we first attempted automatic classification by four-model consensus on face keypoints (nose and eyes): frames were labeled “front” when all four models detected all three points with confidence ?? 0.3, and “back” when three or more models reported all three below 0.3. This labeled 80.9% as front but only 0.1% as back (F1 = .028), with 19.0% ambiguous. Because 73.3% of ambiguous frames fell within manually annotated board-writing intervals, we adopted a hybrid scheme. The first author annotated 35 board-writing intervals across 25 of 27 videos; within each interval, frames where all four models detected face keypoints were excluded as clearly front-facing (4.6%), and the remaining interval frames were labeled back-facing (41,048 frames, 13.9%). All other frames were labeled front-facing. Labels differed by only 25 frames (0.06%) between detector conditions.

3.5 Statistical Analysis

All analyses used the RTMDet condition unless noted. RQ1: Friedman test (N = 27, k = 4) with Kendall’s W; Nemenyi post-hoc. RQ2: Friedman on degradation rates (N = 25, excluding two videos without back-facing frames); per-model Wilcoxon with rank biserial. RQ3: Descriptive statistics. RQ4: Wilcoxon (N = 27) for 16 comparisons (4 models × 4 metrics); Holm correction.

4. Results

4.1 Overall Model Comparison (RQ1)

Friedman tests revealed significant differences on all metrics (Table 2). Detection rate showed the strongest effect (W = .971): RTMPose-m ranked highest (M = .857), followed by ViTPose-b (.808), YOLOv8m-pose (.768), and MediaPipe (.710). All six Nemenyi pairwise comparisons were significant (all $p < .05$).

Table 2. Descriptive statistics and Friedman test results for the four stability metrics (N = 27, k = 4). Values are Mean (SD).

Metric	RTMPose-m	ViTPose-b	YOLOv8m-pose	MediaPipe	Chi2	W
Detection Rate	.857 (.029)	.808 (.038)	.768 (.042)	.710 (.034)	78.64	.971
Mean Confidence	.636 (.027)	.686 (.029)	.703 (.035)	.685 (.035)	56.29	.695
Norm. Jitter	.0055 (.0010)	.0050 (.0013)	.0081 (.0017)	.0067 (.0012)	75.58	.933
Missing Rate	.00053 (.00131)	.00038 (.00111)	.00191 (.00229)	.00165 (.00240)	38.50	.475

All Friedman tests: df = 3, p < .001.
Mean confidence showed a reversed top ranking: YOLOv8m-pose was highest (.703) and RTMPose-m lowest (.636), consistent with architecture-specific confidence distributions. Sensitivity analysis showed stable detection-rate rankings across thresholds 0.1–0.4 (all W > .90), with RTMPose-m and ViTPose-b reversing only at 0.5. Temporal stability formed two groups: two-stage models (ViTPose-b, RTMPose-m; jitter ~.005) were more stable than MediaPipe (~.007) and YOLOv8m-pose (~.008), with significant between-group but not within-group differences; missing frame rate followed the same pattern.
Per-keypoint analysis (Fig. 2) showed that ankles were detected in at most 5% of frames across models, consistent with lower-body occlusion by the lectern. Knees varied substantially under the same condition (RTMPose-m: 81%; MediaPipe: <10%), and MediaPipe also showed lower elbow and wrist detection rates (70–81%) than the other models (95%+).

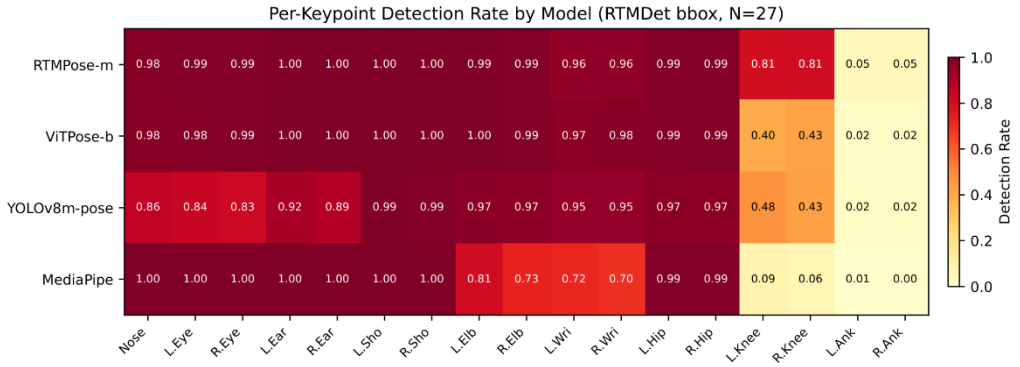


Fig. 2. Per-keypoint detection rate by model (mean across 27 videos, RTMDet condition). Ankles were near zero across models because the lectern physically occluded the lower body; model differences were largest for knees and wrists.

4.2 Front-Facing vs. Back-Facing Performance (RQ2)

Degradation rates differed significantly across models for all three metrics (Friedman, all p < .001; Table 3). Two-stage models showed minimal detection rate degradation (RTMPose-m: 2.2%, ViTPose-b: 1.8%), while YOLOv8m-pose dropped 17.0% and MediaPipe 13.7%. Per-model Wilcoxon tests indicated significant front-to-back differences for all models except ViTPose-b (p = .127, rb = .35)—the only model whose detection rate did not significantly decline during back-facing/board-writing intervals. Mean confidence declined significantly for all models (all p < .001), with YOLOv8m-pose showing the largest drop (24.8%). Jitter worsened for all models, most severely for YOLOv8m-pose (66.5%, SD = 61.6%).

Table 3. Detection rate, confidence, and normalized jitter for front-facing and back-facing frames, with degradation rates (N = 25). Values are Mean (SD).

Metric	Model	Front	Back	Degradation (%)
Detection Rate	RTMPose-m	.860 (.030)	.840 (.041)	+2.2 (4.9)
	ViTPose-b	.810 (.041)	.796 (.045)	+1.8 (6.0)
	YOLOv8m-pose	.788 (.044)	.654 (.051)	+17.0 (7.3)
	MediaPipe	.725 (.039)	.623 (.037)	+13.7 (7.8)
Mean Confidence	RTMPose-m	.649 (.025)	.555 (.039)	+14.6 (5.4)
	ViTPose-b	.698 (.029)	.616 (.041)	+11.6 (6.0)
	YOLOv8m-pose	.729 (.032)	.549 (.043)	+24.8 (6.0)
	MediaPipe	.701 (.039)	.590 (.028)	+15.5 (7.0)
Norm. Jitter	RTMPose-m	.0053 (.0011)	.0069 (.0015)	+35.9 (50.5)
	ViTPose-b	.0049 (.0014)	.0065 (.0016)	+48.8 (74.2)
	YOLOv8m-pose	.0077 (.0017)	.0122 (.0030)	+66.5 (61.6)
	MediaPipe	.0065 (.0011)	.0099 (.0052)	+52.8 (84.9)

4.3 Practical Feasibility (RQ3)

Replacing RTMDet-tiny with YOLOv8n reduced pipeline latency by 26–41% (Table 1). The fastest combination was YOLOv8n + YOLOv8m-pose (33.9 ms, 29.5 FPS); YOLOv8n + RTMPose-m (38.0 ms, 26.3 FPS) balanced speed and output availability. MediaPipe, though slowest (78–107 ms total), is the only pose stage that runs on CPU. All combinations are feasible for offline analysis of three-minute videos.

4.4 Detector Dependency (RQ4)

Of 16 Wilcoxon tests, only two reached significance after Holm correction: jitter for YOLOv8m-pose (RTMDet: .00806; YOLOv8n: .00813; $p = .006$, $rb = -.74$) and MediaPipe (RTMDet: .00674; YOLOv8n: .00703; $p < .001$, $rb = -.95$). Detection rate and confidence showed no significant differences (all $p_{holm} > .19$, mean differences < .003). The statistically significant jitter differences were small in absolute terms (≤ .0003), suggesting that bounding-box fluctuations can propagate to temporal stability without materially changing per-frame proxy metrics.

5. Discussion

The results point to a task-dependent model-selection strategy rather than a single best model. RTMPose-m maximized output availability; ViTPose-b minimized jitter and showed the smallest, non-significant detection-rate decline; YOLOv8m-pose prioritized speed; and MediaPipe provided a CPU-based option. For offline micro-teaching analysis, model choice can be guided by the behavioral features of interest rather than benchmark performance alone.

Two broader points follow. First, confidence distributions differ systematically between SimCC and heatmap architectures, so confidence-based metrics are not directly comparable across architectures. Researchers reporting confidence values benefit from specifying the architectural class to support cross-study interpretation. Second, the selective detector effect on jitter, despite minimal effects on per-frame metrics, shows that bounding-box fluctuations can propagate to temporal stability. Evaluations targeting downstream temporal analyses may benefit from including jitter-aware metrics rather than relying solely on per-frame accuracy [19].

The failure of automatic front/back classification ($F1 = .028$) highlights that current models cannot reliably distinguish orientation from detection failure in classroom settings, motivating domain-specific model development.

The per-keypoint heatmap (Fig. 2) further shows that models differ markedly in which body parts they detect reliably. Near-zero ankle detection reflects the filming configuration rather than model capability; analyses requiring lower-body information would require repositioning the camera or lectern. Within the

visible body, model differences for knees (.09–.81) and wrists (.70–.97) indicate that model selection may benefit from considering the body parts relevant to the intended analysis.
Persistent lower-body occlusion also complicates confidence interpretation. In the present data, this pattern is consistent with the possibility that heatmap peaks decrease more sharply under weak local visual evidence, whereas SimCC softmax scores over discretized coordinate distributions may retain moderate values even when the predicted location is partly inferred from pose context. This is not evidence of a general SimCC advantage for occluded regions: a supplementary inspection of face-keypoint outputs showed higher ViTPose-b confidence in both front-facing and back-facing intervals. The RTMPose-m advantage for lower-body keypoints therefore likely reflects confidence normalization under weak evidence, and the structural plausibility of such predictions requires ground-truth validation.

6. Limitations and Future Work

6.1 Limitations

This evaluation relies on confidence-based metrics rather than ground-truth annotations. Because these scores have architecture-specific meanings, detection rate and mean confidence should be interpreted as output-availability proxies rather than calibrated accuracy measures. While sensitivity analysis indicated stable rankings across thresholds, the absence of pixel-level accuracy measures means we cannot rule out the possibility that maintained confidence under occlusion corresponds to structurally implausible joint positions. All recordings used a single camera in a single classroom in a Japanese teacher education program. Generalizability to other educational contexts—different cultural settings, classroom configurations, age groups, or instructional formats—requires verification. The front/back classification depended on manual annotation of board-writing intervals with model-output filtering and is better regarded as an interval-level approximation than as frame-level orientation ground truth; fully automatic orientation detection remains an open problem. The micro-teaching format also differs from authentic classroom instruction, and behavioral patterns observed here may not fully transfer to in-service teaching. Scale normalization of jitter relies on torso length computed from shoulder and hip keypoints; under persistent lower-body occlusion, uncertainty in hip-keypoint estimates may introduce minor noise into the normalization, though absolute jitter rankings remained consistent across models. Given the descriptive, single-cohort design, the findings should be interpreted as context-bound exploratory evidence for model selection rather than as definitive performance claims.

6.2 Future Work

Three directions follow from these findings. First, partial ground-truth annotation on a representative subset of frames could validate confidence values under persistent occlusion, particularly for SimCC-based lower-body outputs. Second, architecture-aware confidence interpretation—distinguishing outputs grounded in visual evidence from those reconstructed from pose context—could improve the reliability of downstream behavioral analysis. Third, evaluations across multiple classroom configurations and instructional formats would help characterize the boundary conditions of the present findings.

7. Conclusion

This exploratory, single-cohort study compared four architecturally distinct pose estimation models across 27 classroom videos under two detector conditions. All confidence-based stability metrics showed significant model differences, with detection rate ranking nearly perfectly consistent ($W = .971$). Two-stage models ranked higher on output availability and temporal consistency; detector choice had minimal association with the selected proxy metrics except for jitter.
These findings should therefore be read as an evaluation of the technical layer that supports automated feedback, not as an automated assessment of teaching quality itself. For automated nonverbal feedback in teacher education, ViTPose-b is a cautious choice when board-writing or orientation analysis is involved because its detection-rate decline was small and not significant. MediaPipe remains viable when GPU acceleration is unavailable, and RTMPose-m with YOLOv8n offers the highest detection rate at practical speed for balanced offline use. These findings can inform the automated-feedback component of multi-source feedback designs [10] and support selecting classroom pose-estimation pipelines by the body parts and behavioral features needed for feedback, not by benchmark performance alone.

Beyond model selection, two methodological considerations may apply across studies. First, confidence values are not directly comparable across architectural classes; the same numerical value can reflect different generation processes (heatmap peak vs. SimCC softmax vs. visibility score), so cross-study comparisons benefit from architectural disclosure. Second, detector and pose-estimator behavior can decouple on temporal-stability metrics even when per-frame metrics agree, so evaluations supporting downstream behavioral analysis benefit from including jitter-aware indicators alongside per-frame accuracy.

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Finding a Balance between Generative AI and AI-based Tools and Critical Thinking in Legal Education

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Abstract

The use of generative AI and AI-based tools in legal education and legal practice is escalating. A growing number of law firms indicate that they use AI in practice, and learning institutions also report an increased use of generative AI and AI-based tools, by both students and academics. The question is not if generative AI and AI-based tools should be used in teaching and learning, and in legal practice, but rather how it should be done effectively and responsibly while enhancing critical thinking. The use of generative AI and AI-based tools can foster a deeper understanding of law and can help to breach the gap between theory and practice in legal education. It can aid in the formation of individual learning styles and it can offer a more hands-on experience of simulated environments. However, an over-reliance on AI and a loss of human interaction and intervention will skew this process and produce unwanted results and consequences. A balanced and meaningful approach to the use of generative AI and AI-based tools in legal education is needed, where the fostering of critical thinking is combined with the innovation and impact of AI to create an optimal situation for the use of generative AI and AI-based tools in legal education.

Keywords: *Generative AI and AI-based tools, legal education, critical thinking, balance*

1. Introduction

The use and integration of AI into the legal profession and legal education, has influenced and reformed the legal profession as well as the teaching of law [1]. Generative artificial intelligence [GenAI] systems such as ChatGPT, brought a revolution in the manner in which tasks are performed but has also led to greater efficiency together with a multitude of opportunities for innovation [2,3]. GenAI and AI-based tools are positioned to transform legal education and the legal profession in the near future [4]. GenAI systems feature prominently in this specific context since these systems allow for the generation of text since it has been trained to process large amounts of data which are contained in Large Language Models (LLMs). LLMs are also capable of automating the translation of documents, for both research and communication purposes [4].

At higher education institutions the emergence of GenAI offers possibilities as well as significant challenges. GenAI and AI-based tools promote and enhance teaching and learning, as well as research, but its use also highlights the concerns regarding ethical considerations, academic integrity, the protection of data and safeguarding data privacy as well as intellectual property rights (IPR) while considering the ongoing debate centred on the responsible use of GenAI tools [5, 6, 7, 8]. Additionally, and very importantly, GenAI and AI-based tools also engage with the question of critical thinking in legal education, which raises the concern that the use of GenAI will negatively impact critical thinking in legal education.

In legal practice the impact of GenAI is also substantial. The exact reach and nature of this transformation create extensive uncertainty. At the one end of the spectrum certain experts, mainly technologists, predict a fundamental restructuring of the industry, which will lead to AI performing a multitude of legal tasks and might even cause the replacement of certain types of lawyers entirely [9,10]. Others argue that AI is useful to streamline certain aspects, but it will not alter the fundamental nature of lawyering [11].

The use of GenAI in both legal education and legal practice, cannot be denied. In 2025 a survey done amongst 172 UK legal professionals 47 % of them indicated that they are using AI-powered tools to initiate or edit their work, while 87 % of these UK professionals believe that AI will have a significant transformational impact on the legal profession within the next five years [12]. Generative AI and Ai-based tools are also transforming the student experience in tertiary education, having a direct influence on how students learn, communicate and work [13]. AI-related content needs to form part of legal education curricula, and, even more importantly, by empowering students to understand and

acknowledge the capabilities and limitations of AI tools, they will be further equipped to utilise these technologies responsibly to enhance legal practice [14].

2. Generative AI in Legal Education

AI offers the opportunity to personalise learning experiences which cater specifically for individual needs of different students, which in turn improves enhancement and also boosts learning outcomes [15, 16]. GenAI technologies are utilised to develop interactive learning materials, create engaging educational resources, and construct design immersive learning experiences, as well as improving the quality and relevance of educational materials [17]. Another huge advantage of GenAI and AI-based tools is the promotion of inclusivity and accessibility through the selection and application of adaptive learning solutions for students which display diverse learning needs [4]. AI applications are effectively used to enhance learning and teaching activities and assist with academic performance [18, 19, 20, 21].
GenAI, such as Chat GPT assist lawyers in task such as drafting generic, non-legal documents mainly, but not always limited to these documents [4]. Lawyers also use GenAI for more effective case management and it is also used for legal research [4].
This leads to the question: to which extent does AI and, specifically GenAI, threaten to replace essential legal skills? [22] This is a crucial question for both legal education and legal practice. The most sensible way to approach such a question would be to acknowledge the possibilities and potential of AI, as well as to recognise the dangers, challenges and limitations of the use of GenAI and AI-based tools [23].
This paper will specifically discuss the use of GenAI and AI-based tools with regard to the fostering of critical thinking skills in legal education. Critical thinking is an essential skill in legal education as well as legal practice [24] and the use of GenAI and AI-based tools in fostering critical thinking calls for proper discussion and application of these same critical thinking skills.

3. Critical Thinking in Legal Education

Critical thinking is regarded as the “purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based.” [25, p 3] Ideally a critical thinker is “ habitually inquisitive, well-informed, trustful of reason, open-minded, flexible, fair-minded in evaluation, honest in facing personal biases, prudent in making judgments, willing to reconsider, clear about issues, orderly in complex matters, diligent in seeking relevant information, reasonable in the selection of criteria, focused in inquiry, and persistent in seeking results which are as precise as the subject and the circumstances of inquiry permit.” [25, p 3]
One of the models used in legal education is the vocational model which places emphasis on practical skills, while the liberal arts model, emphasises critical thinking [24]. A comprehensive educational approach would incorporate both models in order to create a healthy balance between practical skills and a more nuanced approach to societal issues [24, 26].
Additionally, in the context of legal education skills, such as those proposed above which form part of critical thinking skills, would be extremely beneficial. An Indonesian study focusing on criminal justice education stated that critical thinking skills will assist students to, for instance: “critically assess evidence, question assumptions, and navigate the ethical and systemic complexities of the field.” [246, p 546]. The Indonesian study reflected that critical thinking is a core component of criminal justice education, these skills enable students to assess evidence critically, question
assumptions, and navigate the ethical and systemic complexities of the field. Critical thinking is a fundamental component of criminal justice education, and it equips students with skills to: “analyze complex social issues, question assumptions, and make informed decisions. Incorporating critical thinking into criminal justice programs is crucial for developing a deeper understanding of the field and preparing students to address the multifaceted challenges within the criminal justice system.” [24, p 546]
This can be extended to other branches of legal education and it is clear that the fostering of critical thinking skills better equips law students to fully engage with their legal studies as well as aiding them in expanding and refining their practical skills relating to the study and practice of law.

4. How has AI Assisted in Developing Critical Thinking?

A recent study from a university in Indonesia highlighted the value of AI and AI-based tools in fostering critical thinking. The study involved 100 students who were registered for a criminal justice programme

at the university. Two groups were formed – an experimental group (which followed an "AI-based pragmatic application to analyse authentic Indonesian texts and videos") and a control group which followed traditional learning methods without AI integration." [24, p 550] The experimental group specifically used an AI-powered tool which had been designed to improve critical thinking skills "by analyzing authentic Indonesian texts and videos related to criminal cases." [24, p 550] The tool offers immediate, real-time feedback on the dynamics of communication, e,g. speech acts and non-verbal gestures and cues, which in turn assisted the students to enhance their analytical skills in the solving of criminal matters. The tool uses advanced AI technologies, generative AI and natural language processing (NLP) as well as machine learning (ML) to supply detailed insights into "the structure and meaning of speech acts and conversational strategies within various texts and multimedia content." [24. p 552-553]. The students in the experimental group used the AI tool to do an analysis of case materials such as transcribed witness testimonies and interrogations which have been conducted and recorded [24].

The AI tool utilises multimodal analysis which proved to very beneficial since it led to a greater understanding of verbal and non-verbal clues which is essential when interpreting witness testimonies and interrogations. Video analysis and audiovisual content were provided for a more holistic view. [24]. The experimental group used the AI tool during the course of the whole semester when completing assignments and case studies. The tasks they were given were all simulations of real-world criminal investigations and called for the application of critical thinking skills as well as analytical skills to gain greater understanding of complex issues and to solve these issues [24].

The control group, on the other hand, followed traditional learning methods used for the analysis of criminal cases, such as lectures, readings and discussions. Emphasis was placed on "in-depth case studies on criminal investigations, emphasizing techniques like assessing witness statement credibility, analysing physical evidence, and interpreting non-verbal cues such as body language in interrogations, which equipped students with essential analytical frameworks." [24, p 558]. Students manually, without the assistance of an AI-based tool, analysed testimonies and evidence, while debating issues such as reliability, assumptions, and engaged in a lot of reasoning by means of peer collaboration. They also analysed videos recordings of interrogations and manually reviewed transcribed witness statements and highlighted inconsistencies while analysing key evidence [24]. So, there was a clear difference in the two approaches- one used AI-based tools extensively, and the other one relied on traditional teaching methods. At the conclusion of the intervention both groups took the same standardised critical thinking test [24].

Various instruments were used to assess and measure the critical thinking skills of both groups. This included pre- and post-critical thinking tests, task-based assessments utilising AI applications, student surveys, and semi-structured interviews. The idea was to provide a holistic view of the experiences and performances of the participants, and the study's findings reflected that students who participated listed various advantages of the AI tool that was used. These included: "heightened confidence and improved problem-solving capabilities when tackling complex criminal cases." [24, p 566]. During interviews participants also indicated concrete examples of these benefits as illustrated by the participants. The authors stated that there was "compelling evidence of the transformative potential of AI-enhanced applications," [24, p 567] such as the AI tool that they used during their project. Substantial improvement was noted in argument analysis and evidence evaluation with the participants praising the AI tool's intuitive interface and integration into coursework [24]. On the other hand, the traditional methods that the control group had used, resulted in less significant gains. This, again, highlighted the value that AI can add in deepening cognitive engagement. The authors suggested that AI-based tools and GenAI can be incorporated gradually into traditional lectures while scaffolding AI-related activities and introducing concrete strategies to achieve this. [24].

5. Challenges in the Use of GenAI and AI-based Tools in Fostering Critical Thinking Skills

There is little doubt that GENAI and AI-based tools can add immense values to the development of critical thinking skills in legal education, as the study above suggests. However, there are also concerns that the increased use if AI can impact students' critical thinking skills and ethical reasoning [22]. There is a fear that AI technologies do not cultivate independent legal reasoning or assist students to manage the intricacies and pitfalls of ethical dilemmas [22]. The question arises - can students become overly reliant on AI-based tools and GenAI and in the process dull the development of their critical thinking skills? Might students not become complacent if AI becomes their default position when it comes to critical thinking skills? Farber states that an "overreliance on AI may lead students to accept surface-level outputs without sufficient scrutiny." [22, p 175]. Extending this further to legal practice – what if a

lawyer must address court on a matter and counterarguments and inquiries pop up during trial and there is no opportunity to reach for AI to bail them out? Additionally, especially in the practice of law, various nuances and context-specific aspects find its way into arguments and counterarguments, and AI tools are not structured or fashioned to deal with these nuances. This is where applied critical thinking skills are essential, and although AI can potentially prompt these skills, as displayed in the Indonesian study, it falls short when it comes to the full realisation of such critical thinking skills in legal education and legal practice. Farber refers to the "nuanced judgment essential to criminal practice" [22, p 166] that AI lacks, and it "cannot replicate the complex dynamics of legal argumentation, in-class demonstrations or the nuanced interactions between judges, prosecutors and defence attorneys in a courtroom setting " [22, p 170]

He suggests that experiential learning bridges the gap between theory and practice and will assist the use of AI-based tools and GenAI in offering a more holistic learning experience for students [22]. Such an approach requires the integration of knowledge, skills and aptitude [22]. He seems to prefer the use of AI tools as mere preparatory tools while emphasising that the "live performance reflects the student's autonomous ability to synthesise decide and advocate without technological assistance." [22, p 168]. This experiential learning approach was utilised over three years, from 2022 to 2024, in a criminal law module for students, and Farber reported that it caused an upward trend in student performance across three major written assignments that students had to complete [22]. The use of mock trials, an example Farber cited, clearly reflected the pedagogical value of more traditional methods of teaching and learning. These mock trials require students to engage deeply with core criminal law topics and are dynamic in nature [22]. The students assume different roles e.g. prosecutors, defence attorneys, judges and witnesses, and mock trials call for "unpredictable scenarios and demanded real-time adaptation" [22, p 170] which are aspects that AI-based tools cannot assist students with adequately. Additionally, the mock trials also lead to an overall improvement in student performance and engagement [22].

The use of AI and AI-based tools in legal education needs further exploration and as lecturer in legal education the findings presented in this article, certainly made me reflect on my own teaching and learning. The development and application of such AI-tools need to be considered carefully, since as the Indonesian study clearly showed, a focused and specific approach is more effective than a mere generic approach. This would include substantial research in developing an AI-tool that is specifically geared towards the unique teaching and learning context which each teaching opportunity presents. Collaboration with AI-specialists would also be beneficial in order to forge a strong link between content and establishing a practical, user-friendly AI-tool that focuses on the specific module in which it would be used. Our students have not worked with an AI-tool that has been specifically developed for them, so it would also be important to gain some insight regarding their thoughts on such a tool. At this stage, a pilot project might be the most prudent way forward, where the AI-tool can initially be used for one or two study units within the module to expose students to the AI-tool in a limited manner. Feedback should then be gained and this feedback used to refine the tool. Additionally, the pedagogical approach during this process should also be considered, since the teaching and learning approach is just as important, if not more important, than the use of the AI-tool. Research has also shown that certain, so-called "traditional aspects" of teaching and learning cannot be discarded - a balance between the use of Gen Ai and AI-based tools and a sound pedagogical approach is essential.

6. Conclusion

The relationship between generative AI and AI-based tools and the development of critical thinking regarding legal education, is a complex relationship [22]. AI has potential to assist in transforming student learning and specifically assist in the development of critical thinking. It can assist with argument analysis and evidence evaluation and highlight counterarguments or possibly reveal gaps in reasoning [Farber,2025]. However, experiential learning methods- e.g. mock trials, remain critical in shaping critical thinking and ethical judgment, which algorithms cannot emulate [22]. AI must, however, not be neglected and there is no doubt that it has an important role to play in legal education and legal practice. It must be integrated thoughtfully and serve to amplify skills and competencies students and legal professionals need, rather than replace them [22]. This calls for a balancing act, where there is not an overemphasis of either one of the aspects. The most effective way in which to combine AI tools with more traditional learning methods, such as experiential learning, must be sought. This will lead to students being able to apply law with insight and nuance [22]. There is no doubt that AI-based tools and Generative AI offer a wider scope of legal knowledge and can assist students in a variety of ways, however, AI cannot replace the value of human judgment. [22]. The key is not choosing one or the other but creating a harmony between tradition and technology [22].

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From Signals to Support: A Classroom-Scale Biometric–Facial Research Platform for Inclusive Education

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Abstract

War-affected children in Ukrainian inclusive schools often mask emotional distress, and teachers have no reliable way to detect it [1, 2, 3]. Our previous work introduced BioMirror, an iOS platform that combines ARKit facial tracking with Apple Watch physiology to compute an emotional–physiological coherence score every 5 seconds; adult validation yielded 87.3% emotion-recognition accuracy, sub-50 ms cross-device synchronisation, and 94% biometric signal quality [4]. This paper presents BioMirror Researcher, a macOS companion that uses Bonjour/mDNS and persistent WebSockets to monitor up to 30 iPhones simultaneously. The dashboard provides a device grid, an alert feed, and remote session control, turning a single-participant prototype into a classroom-scale research instrument. We describe the adaptations a school deployment would still need (teacher-facing indicators, an on-device privacy mode, and guided regulation micro-sessions) and propose a mixed-methods pilot for students aged 8–14 in Ukrainian inclusive schools [5, 6, 10].

Keywords: *biometric-facial emotion recognition, inclusive education, war-affected children, emotional regulation, educational technology, research dashboard*

1. Introduction

The full-scale russian invasion of Ukraine has produced one of the largest child displacement crises in recent European history. Millions of children have experienced conflict, forced relocation, and the loss of familiar social structures, all established risk factors for PTSD, anxiety, and disrupted emotional regulation [1]. Ukrainian schools, both inside the country and abroad, now provide inclusive, trauma-informed education to a population whose distress is often invisible [2, 3]. Teachers report that war-affected children often suppress emotional expression and present as calm or disengaged while in fact experiencing significant autonomic arousal [3], which makes it hard to identify students who need support.

Affective computing systems that combine facial analysis with physiological sensing can detect what behaviour alone might hide [7], but most are designed for one-on-one clinical use and do not scale to classroom settings [8]. Doing the same thing in a school is not just an engineering problem. Privacy, teacher workload, and the ethics of collecting biometric data from minors in a conflict zone all bear on the design [9]. Our previous work introduced BioMirror, an iOS implementation of biometric facial emotion analysis for trauma recovery [4]. This paper reports an architectural extension (BioMirror Researcher, a macOS companion that turns the single-device prototype into a multi-device research instrument) and outlines a deployment strategy that integrates BioMirror with art therapy and play-based learning [10] in Ukrainian inclusive schools.

2. Related Work

2.1 Wartime Education and Trauma-informed Pedagogy

Elevated rates of PTSD, anxiety, and depression have been documented in Ukrainian student and teacher populations since 2022 [1]. Refugee studies report the same pattern in classroom behavior (hypervigilance, numbing, withdrawal), often misread as disengagement rather than recognized as

trauma [3, 11]. Inclusive education frameworks call for adapting the environment [12], but the practical tools available to teachers are limited: observations are subjective, standardised assessments are periodic, and specialist referrals are slow in conflict-affected settings [13]. Budnyk et al. [10] looked at this directly. They ran three focus groups in Ukrainian preschool and primary schools (twelve parents of children aged 5–9, five teachers, and four art therapists, psychologists, and rehabilitation specialists), with rural communities affected by the war as the central case. Combining art therapy with play-based learning supported emotional recovery, motor and cognitive rehabilitation, and social reintegration; natural materials (clay, sand, leaves, straw) and folk traditions worked well where formal art-therapy resources were scarce. Two practical problems came up repeatedly. Teachers had no reliable way to tell, during a session, whether a method was actually helping a particular child. And primary school teachers reported that having one teacher for 30 pupils, with no assistant, made it hard to fit the methods into the daily curriculum at all [10]. Related FOE work in VR empathy training [14] and spatial analysis for health education [15] shows an appetite for technology-enhanced socio-emotional learning, but neither addresses continuous monitoring in a trauma-sensitive classroom.

2.2 Biometric Sensing and Ethics

Facial emotion recognition has been used to study engagement [8], but most systems rely on RGB cameras and posed-expression datasets, which limit accuracy on the spontaneous, low-intensity expressions characteristic of trauma masking [11]. HRV and accelerometry provide information about autonomic arousal [16], and multimodal systems outperform unimodal ones [17], but classroom deployment has been hindered by hardware costs and intrusiveness. Two pieces of consumer hardware now make a school-friendly setup feasible. The iPhone's TrueDepth camera exposes 52 ARKit blend-shape coefficients that map to FACS Action Units [18], and the Apple Watch has been validated as a research-grade HRV instrument [19]. Privacy and ethics still constrain any school deployment. Biometric data from minors is sensitive personal data under GDPR, so parental consent and child assent are required [9]. Re-identification risk persists even after anonymisation [20]; in conflict-affected settings, the consequences of misuse are greater [21]; and the digital divide is structural [22]. We address each of these directly in §4 and §6.

3. The BioMirror Platform

3.1 Overview

BioMirror was introduced in [4] as an iOS implementation for biometric facial emotion analysis. The premise is simple: a child's face and their autonomic state, taken together, say more than either does alone. A neutral face with elevated HR and suppressed HRV is a likely sign of masking; a face that moves with the physiology points to real engagement, or real distress. The emotional–physiological coherence score is the central output.

3.2 Facial and Physiological Sensing

The facial component runs on an iPhone using ARKit, which extracts 52 blend-shape coefficients at up to 60 fps; these map closely to FACS Action Units [18]. BioMirror smooths the vector with a two-frame moving average and passes it to a rule-based classifier that maps activations to seven basic emotions at a 0.15 confidence threshold. A 500 ms micro-expression detector flags brief deviations from the neutral baseline that may indicate suppression. Physiology comes from a paired Apple Watch via HealthKit and WatchConnectivity (HR, HRV/SDNN, wrist temperature, respiratory rate, motion); CoreMotion on the iPhone adds acceleration, rotation, a tremor index, and gait metrics. All values are validated against physiological plausibility ranges, and the system derives a stress score (SDNN/RMSSD/LF-HF), a fever-risk indicator, and a breathing classification.

3.3 Coherence Computation

The DataIntegrationService computes the coherence score every five seconds over a 30-second sliding window (Fig. 1). Three weighted components combine: emotional stability (0.3) from emotion-classification variance, physiological state (0.4) from HR/HRV/tremor/temperature, and cross-modal alignment (0.3) from the Pearson correlation between smoothed emotion intensity and the autonomic arousal index. The score ranges from 0 to 1, and higher values mean tighter alignment. A discordance

detector flags two patterns at a 0.4 threshold: a suppressed face with elevated arousal (potential masking), and simultaneous suppression of face and HRV (potential dissociation). Session data persists in Core Data, and the device generates an end-of-session report.

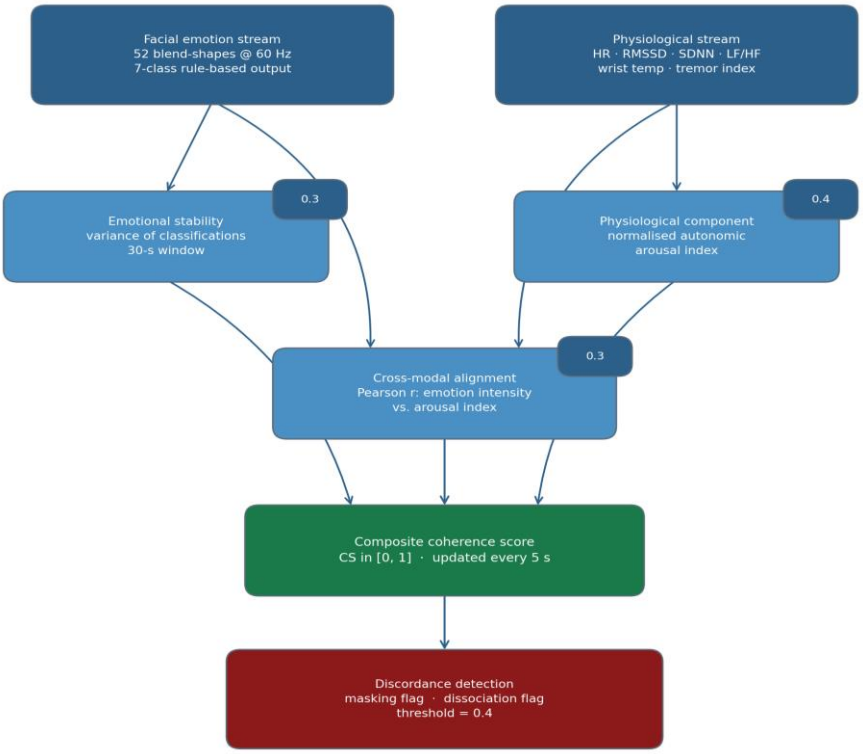


Fig. 1. Coherence computation pipeline

4. BioMirror Researcher: macOS Multi-Device Dashboard

4.1 Architecture

Scaling BioMirror to a classroom means aggregating real-time streams from many iPhones at the same time. We use a hybrid design (Fig. 2). All sensing and coherence computation run on the iOS device. The macOS application is a supervisor: it receives pre-processed summaries, never raw sensor streams. No raw blend-shape vectors and no facial images cross the wire during a session.

The Mac advertises itself with Bonjour over `_biomirror._tcp` and runs an `NWListener` WebSocket server. Each iPhone uses an `NWBrowser` to discover it and opens a persistent connection that retries with a five-second backoff. The link is TLS, and the server's identity is held in the Secure Enclave so the private key cannot be exported. iPhones present a short-lived pairing token on first connect; a researcher generates the token in the Mac dashboard and reads it as a QR code on the phone. Zero-config discovery matters in schools where IT support is thin.

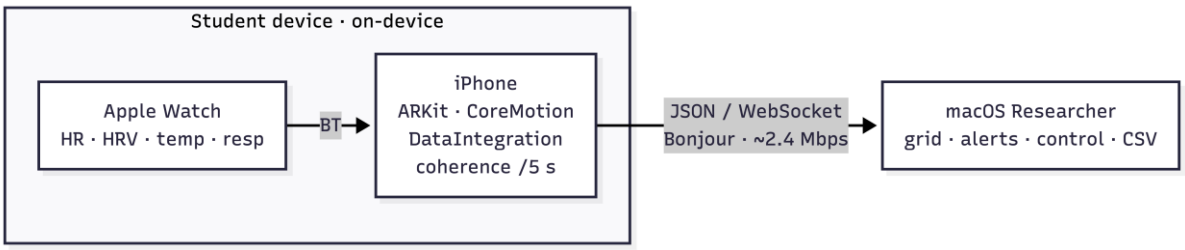


Fig. 2. BioMirror system architecture

4.2 Protocol and Dashboard

Client and server speak a single JSON envelope (`WSMessage`) over the WebSocket. The envelope carries a typed message: `register` and `heartbeat` keep the device list current, `sessionUpdate` streams live metrics every 2 s, `alert` flags discordance events, `command` lets the Mac broadcast start/stop/pause/resume across the cohort, and a chunked `sessionExport*` channel ships gzip-compressed full-session data back to the Mac at the end of a session for offline analysis. Each device sends a heartbeat every 10 s and a metrics update every 2 s with emotion, HR, HRV, coherence, and Watch connectivity, so 30 devices produce well under 3 Mbps on standard school Wi-Fi.
The dashboard has three areas. A device grid shows one card per iPhone with current emotion and confidence, a live HR chart, a coherence sparkline, battery, and Watch link status; cards turn amber or red on low battery, dropped face tracking, or missed heartbeats (>25 s). An alert feed lists discordance events with per-event or bulk acknowledgement. An experiment control panel assigns pseudonymous participant IDs, sends targeted or broadcast commands, and exports the timeline as CSV. The same panel lists the available iOS protocols, marks the ones still in development as "Coming soon", and refuses to start them — the iOS side enforces the same gate, so a teacher cannot accidentally launch an unfinished protocol on a class.

5. From Prototype to Classroom-Scale Research Instrument

5.1 Technical Capabilities

Together, the iOS sensing stack and the macOS dashboard do something the single-device prototype cannot: collect a coherent record across a whole class. Table 1 lists the main performance metrics from adult validation [4] and multi-device system testing.

Table 1. Technical performance metrics of the BioMirror platform.

Metric	Value	Condition
Emotion recognition accuracy	87.3%	Controlled lighting, front-facing, 20 adults
Cross-device synchronization latency	< 50 ms	Local network, 10 connected devices
Biometric signal validity	94%	Normal activity, Apple Watch Series 6+
WebSocket connection stability	98.2% uptime	4-hour continuous session
Battery drain (iPhone 13, screen on)	12%/hour	Active face tracking and streaming
Maximum concurrent devices	30	Standard school Wi-Fi, 2.4/5 GHz
Dashboard update rate	2 s per device	JSON-over-WebSocket
Network bandwidth (30 devices)	< 3 Mbps	Compressed JSON stream
Coherence score update interval	5 s	30-second sliding window
Alert detection latency	< 5 s	Rule-based, evaluated per heartbeat

Thirty devices, sub-50 ms synchronization, and under 3 Mbps of bandwidth all sit comfortably within standard school Wi-Fi. 98.2% WebSocket uptime covers a school morning without reconnection, and at a 12%/hour drain, an iPhone 13 lasts roughly 8 hours. The recognition and biometric numbers are from adult validation under controlled conditions [4]; classifier behavior with children in classrooms is unknown, and is a primary focus of the pilot.
Table 2 compares BioMirror with two alternatives: manual observational coding and single-modality wearables.

Table 2. Comparison with alternative classroom emotional monitoring approaches.

Dimension	BioMirror	Manual coding	Wearable-only
Temporal resolution	5 Hz (emotion), 1 Hz (physiology)	~0.1 Hz	1 Hz
Physiological correlation	Yes (facial + autonomic)	No	Yes (autonomic only)
Classroom scalability	30+ participants	5–8 (observer limit)	15–20
Trauma sensitivity	High (masking + dissociation detection)	Variable	Medium
Implementation complexity	Medium	High	Low
Participant burden	Low (consumer devices)	High	Medium
Privacy risk	Medium (facial data on-device)	Low	Low

5.2 Coherence as a Research Variable

For war-affected children, coherence has two readings. High coherence means the visible emotional state matches autonomic arousal, signalling either engagement or distress. Low coherence means face and body are telling different stories: the child is masking. From a trauma-informed perspective, low coherence is the more clinically significant signal, and exactly the pattern that teachers currently have no reliable way to detect. The multi-device architecture also enables a second-order variable: group coherence synchrony. If several students show correlated drops in coherence after a loud noise or a distressing topic, that may signal a shared trauma response, and the pairwise coherence matrix could inform grouping and the timing of regulatory interventions.

5.3 Adaptations for School Practice

The current dashboard is a research tool, not a classroom one. Three additions are on the design board; none have been implemented yet. The first is a teacher-facing indicator layer that translates raw coherence into colour-coded signals without exposing the biometric data. The second is a hardened minimal-data privacy mode that strips even the identifiers of derived scores from the macOS log. The third is a guided micro-session module that lets the teacher start a regulation activity (a breathing exercise or a short art prompt) and observe the group's coherence response in real time. Fig. 3 shows the layout for a 30-student classroom.



Fig. 3. Proposed classroom deployment

6. Proposed Deployment in Ukrainian Inclusive Schools

6.1. Rationale

The deployment combines two strands established earlier: the mental health crisis among Ukrainian students [1, 2] and the evidence that art therapy and play-based learning support psycho-emotional rehabilitation in war-affected children [10]. Budnyk et al. propose a four-stage pedagogical model — diagnostic, selection, application, evaluation — for folding these methods into the daily classroom.

BioMirror does not yet implement that cycle as a first-class object. What it does do is provide an instrument for the stages that depend on objective signal:

- Diagnostic. The baseline phase of every protocol records HR, HRV, and emotional baseline for two to five minutes. That gives the teacher (or, in phase one, the researcher) a per-child reference for the rest of the session.
- Application. The pilot protocols listed in §6.2 each carry an ordered phase script and always finish with a Regulation phase, so the system de-escalates automatically rather than ending on a creative-task arousal peak.
- Evaluation. Per-session coherence distributions, RR- interval shift vs baseline, discordance counts, and (for the group protocols) a cross-device synchrony view feed back into the teacher journal and post-session interviews.

The selection stage stays with the teacher and the school psychologist; BioMirror does not currently recommend which activity to run next. Building that out — driven by per-child coherence history — is in the §8 future-work list.

6.2. Mixed-methods Pilot Design

The pilot runs in three phases in two to three Ukrainian inclusive primary schools serving students aged 8–14, including both resident and internally displaced children, with at least one rural school to mirror the setting described by Budnyk et al. [10]. The preparatory phase (four weeks) covers ethics approval, parental consent, child assent, Wi-Fi configuration, and teacher training on the dashboard and coherence interpretation, following the guidelines for responsible AI use in academic institutions in [23]. The data collection phase (eight weeks) runs two to three sessions per week, 30–45 minutes each. Of the activities Budnyk et al. document in [10], one is fully runnable in the current build: a guided breathing protocol. The iOS app drives a five-step phase script — Baseline, Paced Inhale at 4 counts, Paced Exhale at 6 counts, a 5-minute Regulation phase, and Recovery — using a SwiftUI breathing circle as a visual pacer. At the end of each session the system reports the mean RR-interval shift between the Regulation phase and the baseline, which is the primary success metric for this activity.

During a session the iPhone runs the breathing script and the on-device facial analysis. The paired Apple Watch streams HR and HRV to the iPhone over HealthKit and WatchConnectivity. The macOS Researcher app aggregates the resulting per-device LiveMetrics from up to 30 iPhones over a Bonjour-advertised WebSocket (_biomirror.tcp) on the school LAN. The dashboard shows one card per child with the dominant emotion, live HR, a coherence sparkline, battery, and Watch connectivity, and a separate alert feed for discordance events. Raw images and blend-shape vectors never leave the iPhone. The connection is TLS. The server's private key is held in the Secure Enclave on the Mac, and each iPhone presents a short-lived pairing token on first connect.

The other four activities documented in [10] are part of the pilot plan but are not yet enabled in the current build: drawing and modelling with natural materials, a collaborative class mosaic or "friendship tree", folk-song-based group play, and story-drawing followed by short theatrical performances. They are scaffolded in the iOS app with the same four-step phase structure (Baseline, main task, Regulation, Debrief), and they appear in the macOS dashboard with a "Coming soon" badge. Both apps refuse to start them via the same planning gate used to block stress-induction protocols for minors. The work remaining before they can run in a school is the per-activity UI for the main task (a drawing canvas for the natural-materials and story-drawing protocols, an audio-cue player for the folk-song protocol, and a shared-canvas component for the class mosaic). The two group activities (mosaic and folk song) already attach a groupSessionID to their iOS payload; the cross-device synchrony computation on the Mac is the next piece of work, and the first round of the pilot will report per-child coherence only.

The researcher monitors the dashboard and logs alerts. Teachers run sessions as normal without access to real-time data and record observations in structured reflection journals. The analysis phase, an indicative four weeks, combines quantitative data (coherence distributions, alerts, and group synchrony once available) with qualitative data: teacher journals, post-session interviews, and student focus groups modelled on [10].



Fig. 4. Proposed three-phase pilot study design.

6.3 Teacher Role and Safeguards

Restricting teacher access to real-time data in phase one avoids confounding the research and lets us evaluate the platform's outputs independently. In a later phase, teachers would get the simplified indicator view (§5.3) with interpretation training; the indicators are one input among many, not a definitive assessment. Several safeguards apply. All facial processing stays on-device, with no images or raw blend-shape vectors transmitted or stored on the macOS server. Coherence scores and emotion classifications are stored under pseudonymous IDs, and the ID-to-identity mapping is held separately by the school administrator. Data are retained for the study duration and deleted afterwards. Participation is voluntary, and withdrawal does not affect a student's standing. The protocol will be reviewed by the ethics committee of Vasyl Stefanyk Carpathian National University before data collection begins.

7. Discussion

7.1 Ethics, Hardware, and the Digital Divide

Facial emotion recognition can encode demographic biases, be repurposed for surveillance, and create power asymmetries between institutions and the people they monitor [9]. The stakes are higher for war-affected children, who are already vulnerable [21]. The architectural choices in §4 and §6 (on-device processing, transmission of derived scores only, pseudonymization, and time-limited retention) reduce these risks but do not eliminate them. The hardware requirement is a separate constraint. BioMirror needs an iPhone and an Apple Watch per student, a significant investment that most Ukrainian schools, especially rural or conflict-affected ones, cannot meet [22]. A deployment available only to well-resourced schools would deepen existing inequalities. The most direct fix is a version that drops the Watch and uses the iPhone's front camera alone; lending and device-sharing models are a shorter-term option [22].

7.2 Teacher Workload and Technical Limitations

Teachers in Ukrainian schools already operate under exceptional pressure [1]. BioMirror is designed to reduce, rather than add, workload by automating distress-signal detection that currently relies on effortful observation, but using it effectively takes some learning. Teachers have to read coherence, interpret the alert feed, and decide how to fold those outputs into what they were already going to do in the lesson. The pilot's training component is therefore central [23]. Over-reliance on algorithmic outputs is a known concern in AI-in-education [24], and phase one mitigates it by restricting teacher access to real-time data.

The platform also has technical limits. ARKit requires the student to face the iPhone at a distance of 30–80 cm, so head turns or peer interactions create data gaps. The rule-based classifier may not capture the full complexity of expression in children with trauma histories [11]. And we have not yet validated the coherence score against established measures of emotional regulation or trauma symptomatology; that requires running standardised psychological assessments alongside BioMirror in a later phase.

8. Conclusion and Future Work

BioMirror Researcher takes BioMirror, originally a single-participant iOS tool, and lets it supervise up to 30 participants at once over Bonjour/mDNS and persistent WebSockets. The iOS sensing stack achieved 87.3% emotion-recognition accuracy, sub-50 ms synchronization, and 94% biometric signal validity in adult validation [4], and the multi-device architecture holds those numbers across 30 concurrent connections on standard school Wi-Fi. The coherence score picks up the masking and

dissociative patterns typical of war-related trauma, which periodic assessments, observational coding, and single-participant systems all largely miss.

Three lines of future work follow. First, run the pilot in two to three Ukrainian inclusive primary schools, integrating BioMirror with art therapy and play-based learning [10] and validating the coherence score against established measures of emotional regulation and trauma symptomatology. Second, build and evaluate the teacher-facing adaptations from §5.3. Third, develop a Watch-free configuration for schools that cannot provide wearables for every student.

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Between Hope, Probability, and Practice: Teachers' Visions of AI-Supported Inclusive Education

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Abstract

This study explores teachers' visions of AI-supported inclusive education through a futures literacy perspective, focusing on how educators distinguish between desirable, probable, and plausible educational futures. Using a scenario-based qualitative design, data were collected from 50 teachers who described future learning environments shaped by artificial intelligence. The findings indicate that teachers primarily view AI as a pedagogical support tool enabling personalised learning, adaptive feedback, immersive environments, and increased accessibility. Inclusive education is mainly conceptualised through learner agency, universal design, and equitable participation rather than deficit-oriented approaches. The analysis identified four configurations of AI-supported inclusive education. The most desirable scenario presents AI as an enabler of learner-centered and inclusive education that strengthens teacher agency and supports diverse learners. However, efficiency-driven systems focused on monitoring, automation, and performance optimisation are perceived as the most probable trajectory. A third scenario highlights ethical concerns, including surveillance, algorithmic bias, and the erosion of human relationships, thereby defining the boundaries of undesirable futures. Finally, a hybrid and negotiated scenario emerges as the most plausible pathway, characterised by context-sensitive AI integration guided by teachers' professional judgement. The findings reveal normative, probabilistic, and pragmatic tensions shaping teachers' anticipatory thinking and demonstrate that inclusive AI futures depend not only on technological advancement but also on ethical governance, institutional conditions, and professional agency. The study contributes to futures-oriented educational research and highlights the importance of futures literacy in supporting inclusive, ethical, and human-centered educational transformation.

Keywords: *futures literacy; artificial intelligence in education; inclusive education; teacher agency; educational futures*

1. Introduction

Artificial intelligence (AI) is increasingly presented as a transformative force capable of personalising learning, improving efficiency, and supporting learner diversity [7]. At the same time, critical scholarship emphasises that educational technologies are not neutral and that their adoption is shaped by social, political, and institutional contexts [10]. These tensions are especially visible in discussions of inclusive education, where questions of participation, equity, and accessibility are central. Most existing research on AI in education focuses on technological capabilities, implementation challenges, or data-driven governance. Such approaches often frame technological change as inevitable while underestimating the ethical and pedagogical implications of AI integration [9]. From a futures literacy perspective, however, the future is not treated as predictable but as a space of multiple possibilities shaped by values, assumptions, and anticipatory thinking [6]. Futures literacy emphasises the capacity to distinguish between desirable, probable, and plausible futures and to reflect critically on the assumptions and values that underpin anticipatory thinking [4]. In educational research, this perspective shifts attention away from forecasting technological outcomes towards examining how different actors use the future as a resource for sense-making and decision-making in the present. Teachers play a central role in shaping how AI is interpreted and enacted in educational practice. As professionals situated at the intersection of policy, technology, and everyday pedagogy, teachers' perspectives provide insight into how future educational change is imagined, contested, and negotiated. Research on teacher agency highlights that educators are not merely implementers of externally defined innovations but active agents whose professional judgement is crucial for ethically and pedagogically meaningful practice [2]. Understanding teachers' future imaginaries therefore offers a window into broader questions about the purposes of education, professional responsibility, and the conditions under which inclusion is pursued or constrained.

2. Methodology

This study adopts a qualitative scenario-based research design grounded in futures literacy. Rather than predicting future developments, the study explores how teachers imagine and evaluate possible futures of AI-supported inclusive education. Scenario-based analysis was selected because it enables the systematic exploration of desirable, probable, plausible, and risk-oriented futures. The research integrates narrative inquiry with futures-oriented analysis. Narrative inquiry supports the exploration of how participants construct meaning through imagined future scenarios [3]. The study additionally draws on the future-scaffolding skills framework [4], which enables the identification of tensions, uncertainties, and anticipatory thinking patterns within participants' narratives [1]. Grounded Theory principles guided the inductive coding process [5].

2.2 Participants and Data Collection

The study involved 50 teachers working in formal education settings in Lithuania. Participants represented different subject areas, teaching experiences, and institutional contexts. Teachers were invited to imagine educational environments in the year 2050 where AI technologies play a significant role in teaching and learning. Data were collected using an open-ended scenario-oriented questionnaire. Participants described future educational environments, reflected on differences between current and future practices, and evaluated the desirability and likelihood of their envisioned futures.

2.3 Data Analysis

The analysis combined thematic coding with scenario-based synthesis. Responses were segmented into meaning-bearing fragments and coded across several analytical dimensions: AI functionality, pedagogical processes, inclusion, ethical concerns, and emotional orientation. The second stage of analysis focused on positioning responses within a futures cone framework distinguishing desirable, probable, plausible, and possible futures.

3. Results

AI is predominantly imagined as a personalising, adaptive, and supportive pedagogical agent, closely aligned with learner-centred and relational educational values. Inclusion is framed less as targeted remediation and more as a matter of agency, accessibility, and participation, indicating a shift away from deficit-based discourses. At the scenario level, teachers' visions are strongly oriented toward desirable futures in which AI enhances inclusive education, while simultaneously acknowledging plausible hybrid arrangements shaped by ethical concerns, infrastructural limits, and professional judgement. These patterns underscore the coexistence of aspiration and caution in teachers' futures literacy, setting the stage for the subsequent discussion of normative–probabilistic–pragmatic tensions in AI-supported inclusive education.

Scenario 1: AI as an Enabler of Inclusive Education

This scenario represents a normative vision of a future in which artificial intelligence (AI) functions as a key enabler of inclusive education, supporting diverse learners through flexible, learner-centred, and equitable educational practices. Participants describe AI not merely as a technological innovation or a tool for efficiency, but as a pedagogical mediator that enables personalised learning pathways, reduces learning barriers, and strengthens social inclusion (INC1, INC2, INC4, INC5; AI-F1). Learning in this envisioned future is grounded in principles of universal design, whereby content, assessment, and learning pace are adapted to individual learners rather than requiring learners to conform to standardised expectations (INC1, CMP4). AI-supported tools provide multiple modes of content representation and continuous formative feedback perceived as supportive rather than controlling (AI-F3, CMP3), as reflected in participants' accounts, for example: "I would like technologies to adapt to each learner, instead of learners having to adapt to the system" (R14). Inclusion is conceptualised through the lens of equity rather than equality, with respondents emphasising AI's potential to support students with special educational needs, language

difficulties, or those at risk of marginalisation by adjusting learning pace, task complexity, and modes of explanation (INC2, AI-F7), as one participant noted: “AI could support students who are currently left behind by adjusting the pace, tasks, and even the way explanations are provided” (R31). Within this scenario, AI is predominantly portrayed as a learning assistant that complements rather than replaces teachers, automating technical and repetitive tasks while leaving pedagogical decision-making and relational work firmly within the teacher’s domain (AI-F2, AI-F4, GOV2), thereby strengthening rather than diminishing teacher agency (PED5, CMP3). This future is also strongly associated with emotional and social well-being, with participants expressing feelings of hope and reduced stress and describing learning environments in which mistakes are framed as an integral part of learning rather than failure (EMO1, PED5), for instance: “This kind of future feels calmer—for both students and teachers” (R22). When positioned within the futures cone framework, this scenario is clearly identified as desirable (CONE-DES) but less frequently perceived as probable, as respondents highlight the need for systemic conditions such as teacher training, ethical and legal regulation, adequate infrastructure, and policy support (CONE-PLAUS; CHG2; GOV1–GOV3), noting that “the system is not yet ready for it” (R9). This reveals a pronounced normative–probabilistic gap (GAP1), further reinforced by respondents’ limited sense of influence over system-level change (GAP5; CHG3), as expressed by one participant: “I can change my own teaching practices, but not the entire system” (R18). Ethical concerns related to data privacy and algorithmic bias are also identified as potential constraints (ETH1, ETH2; GAP3), underscoring the complexity of translating this value-driven vision of AI-supported inclusive education into practice.

Table 1. Scenario 1: AI as an Enabler of Inclusive Education – Core Configuration

Element	Description
In the centre	Learner (diverse needs)
Teacher	Professional judgement grounded in care and relational pedagogy
AI tools	Supportive role enabling personalisation and accessibility
Learning environment	Universal design and flexible learning pathways
Value base	Inclusion as equity, learner well-being, and learner agency

Table 1 summarises Scenario 1, which represents a learner-centred and care-oriented configuration of AI-supported inclusive education. In this scenario, AI functions as an enabling tool rather than a governing force, supporting personalised learning and accessibility alongside teacher professional judgement. Inclusion is understood as equity and meaningful participation, grounded in a learning environment designed according to universal design principles and flexible pathways.

Scenario 2: AI as an Instrument of Efficiency and Control

This scenario represents a future of AI-supported education that is predominantly shaped by efficiency, standardisation, and data-driven governance, and is therefore most frequently positioned as probable within the futures cone framework. In participants’ accounts, AI is primarily associated with automating assessment, monitoring learner progress, and optimising instructional processes at scale (AI-F3, AI-F4, CMP1). Learning analytics, predictive systems, and automated feedback mechanisms are described as central features of everyday educational practice, enabling institutions to track performance, identify risks, and allocate resources more efficiently (GOV1, GOV3). While such uses of AI are often perceived as realistic extensions of current trends (CONE-PROB), respondents express ambivalent emotional responses, oscillating between cautious optimism and concern (EMO3). Inclusion in this scenario is framed more narrowly and instrumentally, focusing on identifying “at-risk” students through data rather than fundamentally redesigning learning environments to accommodate diversity (INC4, CMP5). As one participant noted, “AI would probably help schools see who is struggling faster, but I am not sure it would really change how learning works” (R26). Teachers in this scenario are positioned as implementers of AI-generated recommendations rather than autonomous pedagogical decision-makers, with AI systems increasingly shaping instructional choices, assessment criteria, and pacing (GOV2, CHG4a). Although this redistribution of responsibility is sometimes viewed as reducing workload, it also raises concerns about the erosion of professional agency and pedagogical judgement (CMP3, ETH3), reflected in comments such as “There is a risk that teachers will have to follow what the system suggests, even if it does not fully fit their students” (R11). Emotional and relational dimensions of education receive comparatively less attention in this scenario, and learning is often described in terms of performance indicators, benchmarks, and compliance rather than well-being or belonging (PED5, CMP2). Ethical issues, particularly related to data privacy, surveillance, and algorithmic bias, are recurrently mentioned

as latent risks rather than central design considerations (ETH1, ETH2), suggesting that ethical reflection may lag behind technological implementation. When contrasted with the first scenario, this future is perceived as more likely to materialise but less desirable, revealing a clear tension between what participants expect will happen and what they believe should happen in AI-supported inclusive education. This scenario thus illustrates a probable trajectory of AI integration that prioritises systemic efficiency over transformative inclusion, highlighting the risk that AI adoption may reinforce existing educational structures rather than challenge them.

Table 2. Scenario 2: AI as an Instrument of Efficiency and Control – Core Configuration

Element	Description
In the centre	AI-driven system (data analytics and automation)
Teacher	Implementation of AI-generated recommendations; constrained professional agency
Learners	Monitored through performance data; categorised into risk profiles
Governance context	Accountability frameworks, standards, indicators, and KPIs
Value base	Efficiency, standardisation, and control

Table 2 summarises Scenario 2, which represents a system-centred and efficiency-oriented configuration of AI-supported education. In this scenario, AI-driven analytics and automation structure teaching and learning processes, positioning teachers primarily as implementers rather than autonomous decision-makers. Learners are framed through data-based monitoring and risk categorisation, and inclusion is addressed instrumentally within governance and accountability frameworks rather than through pedagogical redesign.

Scenario 3: AI as a Source of Risk, Inequality, and Educational Regression

This scenario captures a future-oriented perspective in which the integration of artificial intelligence (AI) into education is primarily associated with risk, uncertainty, and potential regression rather than improvement. Participants describing this scenario express strong concerns regarding the ethical, social, and pedagogical implications of AI use, positioning these risks as outweighing its potential benefits (ETH1, ETH2, ETH3). AI is frequently perceived as a technology that may intensify surveillance, reduce human interaction, and exacerbate existing inequalities, particularly for students from disadvantaged backgrounds or those with specific learning needs (INC4, CMP5). Rather than fostering inclusion, AI in this scenario is seen as reinforcing deficit-based approaches to learning, where students are categorised, monitored, and labelled based on algorithmic predictions (AI-F4, CMP3). As one participant articulated, “I am afraid that technology will decide who is capable and who is not, and that this will only increase exclusion” (R33). Teachers’ professional roles in this scenario are characterised by a loss of agency and increased dependency on externally imposed technological systems and policy mandates (GOV1, GOV2; CHG4a), leading to feelings of powerlessness and resistance (CHG3, EMO2). Respondents describe a future in which pedagogical judgement is subordinated to algorithmic logic, raising fears of dehumanisation and the erosion of meaningful teacher–student relationships (ETH3, CMP3), as reflected in statements such as “Education risks becoming a process managed by systems rather than people” (R19). Emotional responses associated with this scenario are predominantly negative, including anxiety, frustration, and concern for the future of education (EMO2), and are often linked to a broader distrust in institutional capacity to regulate AI responsibly. Within the futures cone framework, this scenario is most often positioned as possible but not desirable (CONE-POSS), and in some cases as a plausible outcome should ethical, regulatory, and pedagogical safeguards fail to materialise (CONE-PLAUS; GAP3, GAP4). In contrast to the first two scenarios, this future is characterised less by a debate over implementation strategies and more by fundamental doubts about whether AI should play a significant role in inclusive education at all. As such, the scenario highlights the importance of ethical governance, professional agency, and value-driven decision-making in shaping AI trajectories in education, while illustrating the perceived risks of uncritical or poorly regulated technological adoption.

Table 3. Scenario 3: AI as a Source of Risk and Educational Regression – Core Configuration

Element	Description
In the centre	Perceived risks and uncertainties related to AI use
Teacher	Loss of professional agencies; resistance and ethical concern
Learners	Risk of exclusion, labelling, and marginalisation
AI systems	Opaque algorithms; surveillance and bias
Value base	Ethical caution, protection of human relationships, avoidance of harm

Table 3 presents Scenario 3, which frames AI-supported education primarily through risks, ethical concerns, and the potential for educational regression. In this scenario, AI is associated with surveillance, algorithmic bias, and the erosion of human-centred pedagogical relationships. Teachers express diminished professional agency and principled resistance to AI adoption, while learners are viewed as vulnerable to categorisation, exclusion, and dehumanisation. Rather than enabling inclusion, AI is perceived as a threat to equity and educational integrity, positioning this scenario as possible but normatively undesirable.

Scenario 4: AI as a Catalyst for Hybrid and Negotiated Educational Futures

This scenario represents a hybrid and negotiated future of AI-supported education, in which artificial intelligence is neither uncritically embraced nor fundamentally rejected, but instead integrated through continuous negotiation among pedagogical values, institutional constraints, and technological possibilities. Participants describing this scenario emphasise contextual, cautious, and selective use of AI, highlighting the importance of human judgement, professional autonomy, and situational decision-making (PED1, GOV2, CHG3). AI is perceived as a flexible tool whose role varies across subjects, learner groups, and educational settings, rather than as a uniform solution applied system-wide (AI-F1, AI-F2). In contrast to efficiency-driven models, this scenario foregrounds deliberation and balance, with respondents stressing that AI should support learning only “where it makes pedagogical sense” and be limited where it risks undermining relationships or learner agency (CMP3, ETH3). As one participant explained, “AI can be useful, but only if teachers decide when and how to use it—it cannot work the same way in every situation” (R21). Inclusion in this scenario is understood as a dynamic and negotiated practice, shaped by teachers’ professional judgement and local knowledge of learners’ needs rather than solely by algorithmic recommendations (INC5, INC2). Emotional responses associated with this future are predominantly ambivalent but reflective, combining cautious optimism with awareness of risks and responsibilities (EMO3). Within the futures cone framework, this scenario is most frequently positioned as plausible (CONE-PLAUS), as it aligns with current transitional practices and incremental change rather than radical transformation or technological regression. However, respondents also acknowledge that sustaining such a balanced approach requires ongoing professional development, institutional trust in teachers, and adaptive governance structures capable of responding to rapid technological change (GOV1–GOV3; CHG2). This scenario thus illustrates a future in which AI integration is shaped through continuous sense-making and negotiation, positioning educators not as passive adopters of technology but as active co-constructors of evolving, context-sensitive educational practices.

Table 4. Scenario 4: AI as Hybrid and Negotiated Futures – Core Configuration

Element	Description
In the centre	Pedagogical judgement mediating AI use
Teacher	Active professional agency; contextual and ethical decision-making
Learners	Diverse needs addressed through situational and flexible support
AI tools	Selective and context-sensitive use; supportive but non-dominant role
Governance context	Adaptive frameworks enabling professional discretion
Value base	Balance between inclusion, responsibility, and institutional feasibility

Table 5 summarises Scenario 4, which depicts a hybrid and negotiated configuration of AI-supported inclusive education. In this scenario, AI use is neither fully embraced nor rejected, but mediated through teachers’ professional judgement and contextual decision-making. Teachers occupy a central role in determining when and how AI meaningfully supports learning, while learners’ diverse needs are addressed through flexible and situational practices. This scenario reflects a pragmatically plausible future in which inclusion is pursued through ongoing negotiation between educational values,

institutional constraints, and sociotechnical possibilities.

A comparative synthesis of the four scenarios (see Table 5) highlights how AI-supported inclusive education is configured across different future imaginaries. The table illustrates clear differences in the core orientation of AI use, understandings of inclusion, teacher roles, emotional orientations, and futures cone positioning. Scenario 1 represents a learner-centered and care-oriented configuration in which AI functions as a pedagogical mediator aligned with equity and well-being. In contrast, Scenario 2 reflects a system-centred and efficiency-oriented trajectory, where AI-driven optimisation and monitoring dominate, and inclusion is framed instrumentally within governance and accountability structures. Scenario 3 delineates a boundary of unacceptable futures, emphasising risks related to surveillance, bias, and the erosion of professional and relational dimensions of education. Scenario 4 occupies an intermediate position, depicting a pragmatically plausible future in which AI use is selectively negotiated through teachers' professional judgement and contextual decision-making.

Taken together, Tables 1 - 4 and the accompanying figures demonstrate that teachers' future imaginaries of AI-supported inclusive education are not uniform or linear, but structured along a spectrum of desirable, probable, possible, and plausible futures. Rather than converging on a single anticipated trajectory, participants articulate multiple, sometimes conflicting, orientations toward AI, revealing how values, emotions, institutional logic, and perceptions of professional agency intersect in anticipatory reasoning.

Across open-ended responses, teachers consistently contrasted future AI-supported educational visions with current teaching and learning practices by emphasising limitations of standardisation, frontal instruction, and textbook-centred approaches. The present educational process was frequently described as oriented towards uniform content delivery and assessment, often neglecting learners' individual needs and experiential engagement. In contrast, future visions articulated by teachers foregrounded AI-supported personalisation, visualisation, and real-time feedback as mechanisms for transforming abstract learning into experiential understanding. Respondents provided detailed examples of how AI could reshape subject teaching. In mathematics education, one teacher envisioned a learning environment in which "an AI model would monitor students' actions and understanding in real time and provide individualised tasks together with feedback supported by visual explanations" (translated), contrasting this with current practices focused primarily on formula derivation and uniform problem-solving. Similarly, another respondent emphasised the value of immersive learning, stating that "students could experience much more without leaving the classroom, for example by virtually moving into a Renaissance-era environment" (translated).

Teachers' responses also revealed a strong desire to move away from predominantly passive learning modes. Current classrooms were described as spaces where "students listen to the teacher's explanations, take notes, but have very little opportunity for independent work" (translated). In future-oriented imaginaries, AI-supported environments were associated with increased learner activity, experimentation, and inquiry. At the same time, ambivalence was evident, particularly regarding the risk that AI might replace rather than support cognitive effort. One respondent observed that "more and more students no longer try to think or search for answers themselves, relying instead on ChatGPT" (translated), reflecting concerns about overreliance on automated assistance. The data further highlight a reconfiguration of teacher roles. While the current educational context was described as placing a heavy mechanical workload on teachers, future visions positioned AI as alleviating routine tasks and enabling renewed focus on pedagogical quality. As one participant stated, "teachers' preparation time could be reduced, allowing greater focus on the quality of content rather than its quantity" (translated). In this context, teachers envisioned their role shifting toward mentoring learners in how to learn, reflect, manage their time, and develop values, rather than primarily delivering content.

However, these aspirations were frequently accompanied by concerns about dehumanisation and the loss of relational contact, underscoring persistent tensions between technological potential and educational values. Taken together, these empirically grounded contrasts demonstrate that teachers use future imaginaries of AI-supported education as a means of critically reflecting on current educational shortcomings. The translated excerpts reinforce the scenario-based analysis by showing how normative aspirations, perceived probabilities, and pragmatic concerns intersect in teachers' anticipatory reasoning about inclusive educational futures.

Table 5. Comparison of scenarios of AI-supported inclusive education

Scenario	Core orientation of AI use	Understanding of inclusion	Role of teachers	Dominant emotional tone	Futures cone positioning	Key tensions and gaps
Scenario 1: AI as an Enabler of Inclusive Education	AI as a pedagogical mediator enabling personalised learning, universal design, and learner-centred support (AI-F1, AI-F2, AI-F7)	Inclusion understood as equity and meaningful participation for all learners, particularly those with diverse needs (INC1–INC5)	Teachers as facilitators, mentors, and relational agents; AI complements but does not replace pedagogical judgement (PED5, GOV2)	Positive (hope, inspiration, reduced stress) (EMO1)	Desirable; partially plausible (CONE-DES; CONE-PLAUS)	Normative–probabilistic gap; limited teacher agency at system level; ethical and capacity constraints (GAP1, GAP5, ETH1–ETH2)
Scenario 2: AI as an Instrument of Efficiency and Control	AI used for automation, assessment, monitoring, and optimisation of educational processes (AI-F3, AI-F4)	Inclusion framed instrumentally through identification and management of "at-risk" learners (INC4)	Teachers as implementers of AI-driven recommendations; partial erosion of professional autonomy (GOV2, CMP3)	Ambivalent (cautious optimism mixed with concern) (EMO3)	Probable (CONE-PROB)	Tension between efficiency and relational pedagogy; risk of surveillance and standardisation (CMP5, ETH3)
Scenario 3: AI as a Source of Risk and Regression	AI perceived as amplifying surveillance, bias, and dehumanisation (ETH1–ETH3)	Inclusion undermined through categorisation, labelling, and reinforcement of inequalities (INC4)	Teachers experience loss of agency and increased resistance to imposed technologies (CHG3, GOV1)	Negative (anxiety, distrust, frustration) (EMO2)	Possible; partly plausible (CONE-POSS; CONE-PLAUS)	Ethical gatekeeping failures; distrust in governance and regulation; fear of systemic harm (GAP3, GAP4)
Scenario 4: AI as a Catalyst for Hybrid and Negotiated Futures	AI selectively integrated based on pedagogical relevance and contextual judgement (AI-F1, AI-F2)	Inclusion treated as a dynamic, context-dependent practice shaped by professional judgement (INC2, INC5)	Teachers as active decision-makers and co-constructors of AI use (CHG3, GOV2)	Reflective ambivalence (cautious optimism and responsibility) (EMO3)	Plausible (CONE-PLAUS)	Need for continuous negotiation, professional learning, and adaptive governance (CHG2, GOV1–GOV3)

4. Discussion

The findings demonstrate that teachers do not perceive AI in education as either entirely positive or entirely negative. Instead, participants articulate complex and reflexive future imaginaries shaped by ethical concerns, institutional conditions, and pedagogical values. The desirable future scenario strongly emphasises inclusion, learner agency, and equitable participation. In this vision, AI supports rather than replaces pedagogical relationships and professional judgement. Such findings align with critical perspectives arguing that educational technologies should remain human-centred and ethically grounded [7], [10]. At the same time, teachers perceive efficiency-driven and data-oriented AI systems as the most probable future trajectory. This reflects broader institutional trends towards accountability, optimisation, and datafication in education. Participants' ambivalence towards these developments demonstrates tensions between technological efficiency and educational values. Between these normative aspirations and probabilistic expectations lies a pragmatic space in which teachers seek to synchronyse values with everyday professional realities. This pragmatic orientation is most clearly

articulated in the hybrid scenario, where AI is selectively integrated based on pedagogical relevance, contextual judgement, and professional discretion. Teachers position themselves as active mediators who decide when and how AI can meaningfully support learning, rather than as passive implementers of externally imposed technologies. This emphasis on professional judgement aligns with conceptualisation of teacher agency [2] as central to educational professionalism, while also highlighting that such negotiated futures depend on enabling conditions such as institutional trust, supportive governance, and sustained professional development [8]. The study additionally highlights the importance of futures literacy in educational transformation. Futures literacy enables teachers to critically evaluate possible futures, reflect on ethical implications, and imagine alternative educational pathways rather than accepting technological change as inevitable.

5. Conclusion

This study explored teachers' visions of AI-supported inclusive education through a scenario-based futures literacy perspective. The findings demonstrate that teachers distinguish between desirable, probable, plausible, and risk-oriented educational futures. Teachers predominantly perceive AI as a pedagogical support tool capable of enhancing personalised learning, accessibility, and learner participation. However, participants also express concerns regarding surveillance, standardisation, dehumanisation, and the erosion of professional autonomy. The analysis reveals that inclusive AI futures depend not only on technological capability but also on ethical governance, institutional support, and professional agency. Hybrid and negotiated forms of AI integration emerged as the most plausible educational pathway, highlighting the continuing importance of teachers' professional judgement in shaping inclusive and human-centred educational futures.

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Navigating Ambiguity: A Comparative Study of AI Policies and Student Ethical Frameworks in Romanian, Bulgarian and Swiss Higher Education

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Abstract

This research examines the intersection of institutional Artificial Intelligence (AI) policies in Romania, Bulgaria, and Switzerland with the real-world perceptions and experiences of students using these technologies in academic writing.
Institutional frameworks across these countries increasingly emphasize a balanced approach, promoting responsible use through transparency, mandatory disclosure, and data privacy. If several institutions mandate detailed documentation of AI use, other universities are establishing regulations that differentiate between permitted aids – like brainstorming and editing – and prohibited actions, such as generating entire works.
In contrast, student experiences reveal a significant alignment gap, as learners often navigate these GenAI tools through personal experimentation and peer learning due to inconsistent or nascent formal guidance. Students primarily justify the use of ChatGPT and/or other AI writing tools as a means to increase efficiency and linguistic quality, particularly for non-native speakers, utilizing tools for text refinement, translation, and overcoming writer's block. However, they remain highly cautious, framing ethical boundaries around intellectual ownership and expressing concerns regarding AI "hallucinations," over-reliance, and the potential decline of critical thinking skills.
The findings suggest that while policies focus on regulation and academic integrity, students prioritize practical utility. This highlights a critical need for more adaptive institutional frameworks that move beyond mere prohibition to foster comprehensive AI literacy in European Higher Education.

Keywords: *Higher Education Policies, Academic Writing, Generative Artificial Intelligence, Student Perceptions, Ethical Frameworks*

1. Introduction – AI Use in Academia

The landscape of university policies regarding Generative Artificial Intelligence (GenAI) has evolved rapidly since the release of ChatGPT from OpenAI in late 2022, and it moved from initial reactions of concern and uncertainty to more thoughtful strategies for effective integration [1], [2]. According to current literature, the majority of higher education institutions (HEIs) have adopted an "open but cautious" approach. They seek to balance the innovative potential of generative AI (GenAI) in writing with considerations regarding academic integrity, ethical usage, and data privacy [1]. Most universities have avoided banning GenAI tools completely, recognizing that such prohibitions are largely unfeasible and potentially counterproductive [1], [2]. Rather than adopting uniform institutional policies, universities have opted for more flexible, and inconsistent, approaches, in order to distribute responsibility across various levels of the academic hierarchy.
The most common approach is the one in which the institution delegates decision-making authority to individual faculty members, allowing them to determine the terms of AI use based on the specific objectives of their courses and the framework of their disciplines [1]. The advantage of this method is represented by the flexibility it grants the instructor, who can calibrate the most appropriate AI policy for their discipline and course objectives. However, the method is highly inconsistent and can turn even a single institution into a very uneven environment: students can deal with different – and sometimes contradictory – rules from one course to the other.
Another approach would be the opposite, a restrictive policy imposed by the institution: forbidding AI use unless an instructor permits it in the syllabus. While this method could help create an ethical ecosystem, students would not have the opportunity to engage with AI tools in an official manner. Inevitably, they would use AI, even though it is prohibited.

The last case is when universities allow the use of GenAI tools, provided that students follow strict citation and attribution rules [1], [2]. This transparency regarding the nature and extent of AI involvement treats AI as a legitimate research assistant and holds students responsible for the final submission.
This disparity in regulation is defining the current worldwide academia. At the international level, there is a significant difference in the perception of GenAI between institutions operating in various states. Moreover, at the national level, even where governments have begun to issue recommendations, these rarely translate into coherent independent policies, due to institutional autonomy. And at the institutional level, students are often confronted to ambiguity in AI regulations and recommendations provided by professors.

2. Project TRAI – A Three-fold Perspective

In order to map this landscape empirically, the present study selected three countries – Romania, Bulgaria, and Switzerland – as comparative case studies, all participating in a MAPS (Multilateral Academic Project, funded by SNF – Swiss National Science Foundation) project titled *TRAI*, "Exploring the Triad of Academic Writing, Critical Thinking and AI Literacy: Interdisciplinary Perspectives on Undergraduate Thesis Writing" (https://trai.uvt.ro/). The project aims to understand, analyse, describe, and extract information relevant to Higher Education regarding the relationships within the triad formed by academic writing, critical thinking, and the use of artificial intelligence, since students are already widely using Large Language Model tools, such as ChatGPT, even though institutional policies regarding their use are still under development. For each country, all publicly available AI-related policies and guidelines issued by higher education institutions were identified and analysed, with the aim of producing a comprehensive picture of how GenAI is currently being regulated (e.g. ZHAW – Zurich University of Applied Sciences, ETH Zurich, University of Bern and University of Zurich for Switzerland; Sofia University "St. Kliment Ohridski" and American University for Bulgaria; West University of Timisoara, Politehnica University of Timisoara and "Carol Davila" University of Medicine and Pharmacy for Romania).

3. AI Institutional Regulations

In HEIs from Romania, Switzerland, and Bulgaria, institutional policies regarding the use of GenAI revolve around several principles: transparency in use, human accountability for outputs, and the preservation of academic integrity. A common statement emerges from the official regulations: AI may assist students in research and writing, but it may not replace their critical thinking and authorship. Most institutions across the three countries position GenAI as a legitimate tool, capable of supporting tasks such as brainstorming, text editing, language refinement, but they explicitly forbid its use in in ways that would substitute the student's own intellectual contribution, particularly in the production of original arguments, critical analysis, or written works submitted for assessment.
In Bulgaria, an interesting aspect extracted from the institutional policies is related to the necessity of developing AI literacy among both students and professors. There is a strong recommendation for taking AI literacy courses for the academic community, in order to understand the limitations and ethical risks of the AI technology. Moreover, both faculty and students are required to disclose AI use to maintain intellectual honesty (see American University in Bulgaria, [3]). Overall, the Bulgarian institutions focus on an ethical commitment of academia.
In the Romanian context, institutions tend to require students to produce formal written declarations attesting to the degree and manner of AI use (see especially the West University of Timisoara case, [4]). The prioritization of an administrative procedure reflects a commitment to transparency, it risks tipping into administrative overreach, a factor that is actually traditionally embedded in the Romanian educational system. In a higher education system already marked by significant bureaucratic overload, the risk is that transparency becomes an end in itself, reduced to a signed form rather than a reflective practice. However, the three Romanian institutions examined in this study represent different academic profiles – a comprehensive, theoretically oriented university, a medical university, and a technical university – and their AI policies reflect, perhaps unsurprisingly, the distinct epistemological cultures. The medical university adopts the most permissive approach among the three and explicitly enumerates the tasks for which GenAI is considered appropriate, such as: generating outlines and structures for scientific articles or thesis chapters, assisting with the formulation of clear and concise paragraphs, correcting grammatical, stylistic, and logical coherence errors, and refining academic language to meet the precision standards required for publication in high-impact international journals [5]. This granularity reflects a field in which writing is understood primarily as the communication of knowledge, and the

institution does not seek to develop academic writing skills per se. The comprehensive university has a more decentralized approach, creating a general framework and delegating decision to individual faculties, allowing each to develop guidelines calibrated to the specific demands and conventions of their discipline. This flexibility acknowledges the differences between specific fields of knowledge (for instance, Philology vs Computer Science), but imposes the risk of inconsistency [4]. The technical university has a median position, emphasizing transparency and process documentation, but raising awareness regarding authorship and intellectual property [6].

Swiss institutions have adopted a proactive strategy, and the country is the most policy-rich ecosystem among the three countries examined, in terms of both the volume of available institutional documents and the degree to which they address the specifics of GenAI. Swiss higher education institutions appear to be considerably more advanced in their policy development. They have moved beyond general ethical statements and now have detailed, practical frameworks that address the technical, legal, and pedagogical aspects of AI use. For instance, the University of Bern requires students to "create a log that keeps track of which tools are used for which section" [7]. ZHAW, University of Zurich and University of Bern state that the use of AI tools in the context of academic work, however minor or peripheral, must be explicitly acknowledged and documented [8], [9].

To sum up, the Swiss institutional culture underlines an emphasis on technical process documentation. Many Swiss universities require verifiable evidence of the writing process itself – including logs of AI interactions, records of the prompts submitted at different stages of the task, and successive versions of the text, that allow reviewers to trace the evolution of the paper from initial AI-assisted draft to final submission.

Table 1. Summary Table of Institutional Policies

Policy Aspect	Bulgaria	Romania	Switzerland
Responsibility and decision-making	Human	Human	Human
Disclosure and transparency	Mandatory at the beginning of assignments, proper citation needed	Mandatory for every task – in some cases, students fill in a transparency statement regarding the use of tools based on GenAI	Mandatory, often requires logs or transcripts as annex
Syllabus	Teachers must define specific permissions in the Syllabus	Teachers must define AI rules in the Syllabus for every task	Departmental specific guidelines
Data Privacy	Adherence to GDPR	Adherence to GDPR	Adherence to GDPR

4. Students' Perceptions

In order to examine the extent to which these institutional policies actually are implemented and internalised, three students were interviewed from each of the countries included in the study, resulting in a total of nine interviews across the three national contexts (three from ZHAW, three from Sofia University "St. Kliment Ohridski", three from West University of Timisoara). This interview component aimed to see students' perspectives regarding the use of GenAI and whether the institutional policies are sufficiently spread among students. More specifically, the interviews aimed to analyse students' own understandings and experiences of GenAI use in academic writing, their awareness of the policies from their respective institutions, and their assessments of whether GenAI can change an more epistemological dimension: how the use of AI tools shapes their relationship to knowledge itself, whether engaging with AI-generated text changes the way they read, evaluate, and assimilate information; whether the externalization of certain cognitive tasks to AI affects their sense of intellectual ownership over the final work.

An important note is the temporal context of the interviews: conducted in 2025, they took place at a moment when several of the institutional policies examined in this study were either newly issued or still in the process of being formally implemented. This is why student experiences reveal a significant alignment gap, as learners often navigate these GenAI tools through personal experimentation and peer learning due to inconsistent policy.

Among the students interviewed, ChatGPT appears to be the most widely used AI tool, but students often combine it with more specialized applications, like Perplexity for evaluating sources, and DeepL for translation and the refinement of academic language.

Despite the differences in national policy contexts and institutional cultures, the students interviewed across Romania, Bulgaria, and Switzerland develop several common beliefs or practices:

- Autonomy: Students permanently position themselves as the decision-maker in any AI-assisted task – the one who sets the direction, evaluates the outputs, and has the responsibility for the final submission.
- Assisted Writing: The role of the student in the writing process becomes more and more that of an editor – AI-assisted writing means that AI tools are used for literature review, evaluating, correcting, and refining the text.
    - A major application of AI is improving the academic language of a text and translating content between languages. Students who are not native speakers of the language they are writing in often rely on AI to correct grammar or choose appropriate vocabulary.
    - AI acts as an advanced search engine that helps students find relevant literature for their topic.
    - Students frequently use AI to summarize academic papers or abstracts, using these summaries as a preliminary filter to assess whether a source is relevant enough to their topic.
- Risks in Academia: Students are concerned about AI dependency [12], AI hallucinations and academic integrity, and therefore are aware that they need to verify information provided by AI.

A closer reading of the interviews reveals that students from Bulgaria, Switzerland, and Romania slightly differ in how they engage with AI tools, especially because of their distinct disciplinary contexts. Among the Bulgarian students interviewed, AI use is predominantly related to technical and often repetitive tasks (such as document formatting in LaTeX, debugging and optimizing programming code). Moreover, Bulgarian students tend to have a selective approach: they use AI only in areas where they already have a background knowledge to recognize, intuitively, whether the output is plausible and consistent with what they know. This technically oriented pattern of AI use reflects the disciplinary profile of the Bulgarian students interviewed. Swiss students exhibit a more sophisticated model, viewing themselves as a “conductor of an orchestra”. What is more, there is a high level of technical literacy regarding AI among Swiss students: they are aware of prompt engineering techniques and often use one AI to optimize prompts for another AI to ensure a better output. Among the Romanian students interviewed (predominantly from the fields of Languages and Literatures) use AI for thematic brainstorming (e.g., exploring certain motifs; see also [10]) and explaining complex theoretical concepts. In this case, AI functions less as a writing assistant than as a thinking partner Also, the responses showed a strong emphasis on the fear of “imposture”, which reflects a more personal anxiety related to intellectual property, authentic authorial voice and domain-specific standards. The ethical dimension of AI use in this field is experienced more as a question of personal and professional integrity.

5. Discussion and Conclusions

From the institutional policies examined in Romania, Bulgaria, and Switzerland, three common principles emerge: citation of AI-generated content, fact-checking, banning presenting AI-generated work as one's own independent contribution. A strong consensus among interviewees is represented by the belief that AI should primarily function as a tool, instead of replacing intellectual work.

All institutions examined are consistent in their position that AI outputs do not represent scientific sources and may not be treated as such. Where AI has contributed to a text students have to acknowledge the use of AI in accordance with established academic citation standards. However, since standard citation formats were not originally designed for AI outputs, students are often left to navigate ambiguity about how precisely to cite a tool rather than an author. Nevertheless, university policies require students to verify the accuracy of any content produced or suggested by an AI tool since students are fully responsible for the factual integrity of their work. This fact-checking practice acknowledges that AI outputs are not yet reliable sources and that students need to develop the critical evaluation skills necessary for this task.

The convergence between the three countries marks the fact that there are common shared values prioritized by institutions, but there is an uneven development of implementation [11], which leaves a considerable interpretive space for both faculty staff and students to navigate.

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Artificial Intelligence for Education: The Role of Inner Skills

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Abstract

Artificial Intelligence (AI) is rapidly reshaping teaching practices and learning processes. While offering unprecedented opportunities for personalized innovation, AI poses new risks to cognitive development, critical thinking, and the overall well-being. Drawing on insights from previous digital revolutions (e.g. smartphone and social media), this paper argues that the future of education demands combining technical AI literacy with the development of inner skills, such as presence, awareness, critical reflection, and ethical responsibility. Building on successive European university initiatives (StudentWell, AI4Well, and AI4WellEdu funded by EUniWell), this research presents a transdisciplinary educational approach aligned with the Inner Development Goals (IDGs) framework. The paper introduces the Well-being-oriented AI Literacy Framework, an experiential paradigm where technical competence and inner development are mutually reinforcing. Preliminary findings from Mindfulness-based Focus Groups involving students and educators highlight that cultivating internal human capacities is not an optional addition, but an essential foundation to ensure that AI enhances, rather than diminishes, human development and flourishing.

Keywords: *AI in education; AI literacy; Well-being in education; Inner skills; Digital teaching and learning; Responsible and mindful AI adoption.*

1. Introduction

Written language has always been one of the most transformative innovations in human history, shifting how knowledge is preserved and transmitted across space and time. Yet, what we now consider an indispensable foundation of culture was initially met with philosophical scepticism. Socrates, for instance, left no written records, viewing philosophy as a living practice grounded in spoken dialogue. In his view, writing carried structural risks: it was inherently static and unable to clarify itself when questioned, it risked weakening human memory by shifting reliance to an external medium, and it risked creating an illusion of knowledge, where the accumulation of information is mistaken for genuine understanding. As writing evolved through paradigm shifts, from the printing press to the web and, ultimately, to AI, the core of the Socratic warning remains profoundly relevant. Every cognitive tool must be approached critically, balancing its clear opportunities against its structural risks. The challenge is not to reject innovation, but to govern it responsibly. Today, we face an unprecedented technological wave: first with smartphones and social networks, and now with AI. While mobile devices and social platforms facilitated real-time connection and instant access to information, their pervasive use among younger generations has frequently replaced essential developmental activities like free play and direct social interaction. Extensive literature now links this digital saturation to an increase in anxiety, depression, and socio-emotional fragility among Generation Z, highlighting how technological tools can fundamentally reshape human cognitive and psychological development [1]. Today, the rapid rise of AI represents a new and powerful challenge that calls for careful consideration, particularly with regard to how and when it should be integrated into the educational process. It is imperative to understand and mitigate the possible risks, such as critical thinking erosion and cognitive dependency, while actively guiding its development toward its beneficial potential. To address this challenge, the *AI4WellEdu* project analyzes the integration of AI within the educational sector from a transdisciplinary perspective. Building on the cumulative experiences of the *StudentWell* (Student Well-being) [2, p. 150-177], and *AI4Well* (Artificial Intelligence Ethics for Well-being) [2] projects, all funded within the initiative of the *EUniWell* (European University for Well-being) alliance this project proposes a *Well-being-oriented AI Literacy Framework*. Aligned with

the *IDGs framework* [3], this approach integrates technical AI training with the structured cultivation of inner skills (e.g., awareness, deep listening, critical reflection). The *AI4WellEdu* framework argues that inner skills is not an optional extra, but an essential foundation to ensure that AI enhances, rather than diminishes, human development and intellectual autonomy. The paper is structured as follows: Section 2 introduces the concept of inner skills, while Section 3 presents the *StudentWell* project and its main findings. Sections 4 and 5 address the challenges posed by AI to well-being and education, presenting the AI4Well and AI4WellEdu projects. Specifically, Section 5 analyses systemic risks within the education sector and outlines concrete strategies for adopting AI in a way that promotes human development rather than inhibiting it. Finally, Section 6 presents the main conclusions drawn from this first phase of the *AI4WellEdu* project's research.

2. Inner Skills

Inner Skills refer to the psychological, emotional, and cognitive capacities that enable individuals to manage their internal complexity in order to act efficiently and ethically in the world, while fostering well-being for themselves and others. Within this paradigm, personal transformation is the fundamental prerequisite for collective change: the maturation of internal competencies naturally manifests as responsible external action. Rather than optional extras, these skills represent the human foundation necessary to navigate global changes, a perspective strongly reinforced by the *2023 UNESCO Recommendation*, which advocates for cultivating inner development to foster behaviors, communication, and relationships based on openness, inclusion, and reciprocity. This process requires "*returning to one's home: listening deeply to the body, emotions, and complexity. This process allows one to embrace personal diversity, conflict, and suffering, reflecting the challenges of the external world. Such inner care naturally extends to the outer world, fostering relationships based on interconnectedness*" [4, p. 61]. In order to put this approach into practice, the *IDG Framework* [5] offers a multidisciplinary model linking inner change growth with global change. Developed in alignment with the *UN Sustainable Development Goal*s (SDGs), the *IDG Framework* recognizes that systemic, macroeconomic change requires individual psychological evolution. The framework is articulated through 25 core skills organized into five macro-dimensions: *Being* (e.g., self-awareness, presence), *Thinking* (e.g., critical thinking, systems thinking), *Relating* (e.g., Connectedness, Empathy and Compassion), *Collaborating* (e.g., Relationship-Building, Inclusive Mindset and Intercultural Competence), and *Acting* (e.g., Courage, Hope and Optimism).

3. StudentWell Project: Inner Skills and Mindfulness

StudentWell (Supporting and measuring student well-being through cross-university interventions) aimed to enhance student well-being by addressing stress, anxiety, and mental health challenges while fostering inner skills. The project has implemented initiatives focused on well-being at universities and has launched a pilot approach to define and test the so-called *Well-being Working Methodology* [2, p. 153]. Specifically, *StudentWell* demonstrated that the mindfulness-based protocol, developed and tested at the University of Florence, shows that a path based on awareness is capable of developing nearly all the inner competencies included in the *IDG Framework*, and an improvement in participants' well-being, measured via the Well-being Numerical Rating Scales (WB-NRSs) [6].

3.1 The 7-week Mindfulness-based Protocol

The 7-week Mindfulness-based Protocol [2, p. 156-158] is a secular intervention rooted in the mindfulness teachings of Zen Master Thich Nhat Hanh [7]. The protocol is designed to enhance participants' psychological resilience and well-being through an experiential and transformative curriculum. By integrating meditation, physical relaxation, and deep listening with practices from bio-natural disciplines, the program operates on the principle that cultivating present-moment awareness is a fundamental prerequisite for transforming one's inner state. The intervention consists of seven weekly sessions, each lasting 90 minutes, and is systematically divided into two developmental phases that bridge somatic awareness with behavioral transformation: *Phase 1: Inhabiting the Body (Weeks 1–3)* - Focuses on shifting from mental activity to bodily awareness through breathing, grounding, and posture correction. *Phase 2: Inner Transformation and Action (Weeks 4–7)* - Aims to cultivate advanced meta-competencies, such as concentration, deep listening, and emotional regulation, to face academic, professional, and personal daily challenges. Each session follows a standardized, reproducible pedagogical flow alternating an initial presentation, body exercises, deep relaxation, a brief impulse,

contemplative insights, and reflective sharing in groups designed to leverage collective intelligence. *StudentWell* demonstrated that this structured, awareness-based path is capable of developing nearly all the inner skills included in the *IDGs Framework*, while simultaneously generating a measurable improvement in participants' well-being.

3.2 Results

To evaluate the pedagogical efficacy of the training, qualitative 30-minute interviews with the teaching staff were paired with structured questionnaires mapping the *IDG framework* [2, p. 172-177]. The qualitative data underscored a positive transformation in both individual well-being and collective classroom dynamics. Teachers have noticed a marked increase in engagement and concentration; as the sessions progressed, external distractions have gradually disappeared. There has been no use of mobile phones at any point. This shift directly enhanced students' concentration, intuition, and emotional awareness. Furthermore, the structured protocol fostered a culture of reflective inquiry and deep listening, which significantly lowered academic anxiety, reinforced group solidarity, and promoted prosocial behaviors such as empathy, ethical conduct, and collaboration. Findings also indicate a generalized increase in well-being scores among all participants (Fig. 1).

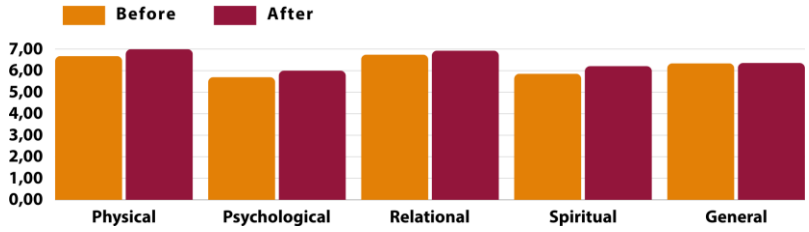


Fig. 1. The impact on well-being measured after the 7-week *Mindfulness-based Protocol (WB-NRS scale)*.

Although the limited sample size (n = 14) of this pilot study precludes broader generalization, the data demonstrates that the WB-NRS successfully captured fluctuations in well-being within a small cohort. Future research involving larger sample sizes is required to validate and expand upon these preliminary pilot results.

4. AI4Well Project: Inner Skills and Artificial Intelligence

AI4Well (Artificial Intelligence Ethics for Well-being) [2] builds on the PhD thesis *"Artificial Intelligence Ethics for Well-being based on the Sustainable Development Goals"* [8], and examines how ethical principles can be implemented across the entire AI ecosystem, from design to adoption. By integrating psychology, anthropology, computer science, communication, education, well-being, and mindfulness, the project highlights that responsible AI requires more than regulatory compliance; it depends on cultivating the inner skills needed to act ethically in technologically mediated environments. Grounded in the *IDGs framework*, *AI4Well* positions AI ethics within a broader vision of human flourishing and ecological responsibility, proposing a model for universities and policy actors to navigate technological disruption. To translate these theoretical principles into practice, the project implemented a dual approach combining action-research methodologies and educational pilots: 1) *Mindfulness-based Focus Groups* - A series of focus groups was conducted to explore stakeholders' perceptions of AI. Structurally, these sessions paired introductory technical insights with short mindfulness practices and silent contemplation key themes, creating a reflective space that stimulated deep collective sharing and dialogue among participants [2, p. 198-199]. 2) *The Unlock the Potential of AI for Well-being Workshops* - This pilot training programme was delivered in four fully online workshops to test scalable educational models. Rather than focusing exclusively on technical AI literacy, the workshops integrated technical modules with inner development practices. The curriculum systematically guided participants through sequential phases: establishing presence and somatic grounding, mapping digital well-being through self-reflection, analyzing the geopolitical and environmental impacts of AI, and engaging in transdisciplinary co-creation [2, p. 199-204]. By blending technical competence with inner skills, these training courses demonstrated that promoting a conscious and responsible use of AI is not merely a matter of institutional compliance, but of cultivating the human capacities required to guide technology toward sustainable and well-being-oriented outcomes.

4.1 Results

Evidence emerging from the AI4Well workshops and mindfulness-based focus groups shows that navigating the integration of AI into education requires a profound pedagogical shift, centered on a conscious-oriented approach rather than passive adoption [2, p. 206-213]. A key finding of the research is that traditional technical training alone is wholly insufficient to handle the multi-faceted cognitive and ethical complexities of an AI-driven environment. Without structured oversight, over-reliance on AI-powered generative tools risks eroding students' critical thinking, analytical depth, and capacity for original insight. Consequently, the project's main result highlights the urgent necessity of redefining AI literacy through a holistic triad that blends technical proficiency, ethical awareness, and inner skills. Grounded in the logic of the *IDG framework*, the findings advocate for making inner skills training an essential component of educational curricula, positioning these human competencies as critical cognitive anchors. Much like the systemic challenges faced by the *SDGs*, AI adoption currently suffers from a significant gap between theoretical ethical frameworks and concrete, day-to-day action. The *AI4Well* results confirm that cultivating an alliance between technical competence and inner development is an effective strategy to bridge this gap, ensuring that technological adoption is actively guided toward human flourishing, intellectual autonomy, and responsible digital citizenship.

5. AI4WellEdu Project: Artificial Intelligence in Education

AI4WellEdu (Artificial Intelligence for Well-being in Education) builds on the foundations of *AI4Well* and seeks to tackle the pressing challenges of AI for well-being in educational settings. Because AI is currently having a highly disruptive impact on education, it is imperative to closely examine its long-term effects on human development and well-being [9][10][11]. Although the impact of digital technologies on education and well-being has been extensively investigated in recent years [1][12], with studies highlighting both the potential benefits and the structural risks associated with AI [13][14], there remains a widely acknowledged and critical call for further research to address these emerging issues [15][16]. While many studies underscore AI's potential contribution to well-being and human development [17], its practical application, particularly within educational environments, still faces significant challenges that must be addressed. Recently, the *EU AI Act* [18] has sought to address these challenges through regulatory measures; however, top-down legislation alone is insufficient. It is equally necessary to cultivate the internal human capacities and inner skills required to design and adopt AI responsibly [2]. *AI4WellEdu* addresses these specific educational challenges by designing a structured training program that develops inner skills alongside targeted technical training on AI. This approach is firmly rooted in the *Well-being Literacy Framework*, which was designed and piloted in *AI4Well* [2, p 199-204.]. *AI4WellEdu* aims to further develop and test this methodology with a larger and more diverse group of participants. The objective is to deliver three sessions consisting of four workshops each, from which additional feedback will be gathered for both qualitative and quantitative analyses. Furthermore, while the original *AI4Well* workshops "Unlock the Potential of Artificial Intelligence for Well-being" were delivered exclusively online, *AI4WellEdu* plans to conduct at least one in-person session over three consecutive days. Implementing these two distinct delivery modes will allow for a rigorous comparative analysis of the results obtained. As in *AI4Well*, a multidisciplinary expert group (comprising specialists in AI, ethics, mindfulness, pedagogy, psychology, and neuroscience) will guide the definition and structuring of the course content based on the core concept of well-being. To further support the content design and the pedagogical methodology adopted in *AI4WellEdu*, at least five series of focus groups will be conducted. These sessions will adopt a transdisciplinary approach involving experts from a wide variety of disciplines. Notably, several focus groups will be dedicated exclusively to students to capture their direct perspectives and experiences, a contribution we consider fundamental to this initiative. The expert committee will also be actively involved in the subsequent data analysis phase. The *AI4WellEdu* project launched in mid-December 2025. To date, the first expert group meetings and initial focus group sessions have taken place. This paper presents and analyses the empirical findings that have emerged from these initial stages of the project.

5.1 Mindfulness-Based Focus Groups: Views of Students, Educators, Researchers, and Experts

Building on the methodology established in *AI4Well*, a series of *Mindfulness-based Focus Groups* was conducted within *AI4WellEdu* to deeply explore the psychological, cognitive, and systemic impacts of generative AI in education. Currently, three focus groups have been completed using identical structure and timing parameters. These sessions involved a total of nine researchers, experts, and lecturers from

various disciplines, including psychology, neuroscience, mindfulness, well-being, and AI, alongside five students from different degree courses, such as psychology, communication, and economics. By embedding short contemplative practices and deep listening within a multidisciplinary group setting, the sessions encouraged participants to reveal their authentic emotions, fears, and daily habits regarding AI. The thematic analysis of the qualitative data yielded a complex map of emotional, cognitive, relational, and structural dynamics, which can be synthesized into five key themes: 1) *The Emotional-Relational Dimension and Students' Needs* - In an environment marked by academic pressure and structural uncertainty, students frequently turn to generative AI not just as a study aid, but as an emotional buffer, virtual companion, or pseudo-therapist. While this highlights unfulfilled listening needs within traditional higher education, it raises critical concerns regarding emotional dependency, technology anthropomorphization, and exposure to harmful or inaccurate outputs without professional guidance. In this regard, students highlighted that if AI is to be explored as a tool for emotional regulation during stressful exam sessions, its biases and risks must be strictly evaluated and explained by certified psychotherapists. 2) *AI, Learning, and Critical Thinking* - A prominent tension emerged regarding cognitive automation (e.g., text generation, summarizing). The data revealed deep anxiety that bypassing the productive effort of independent study might progressively erode memory, analytical depth, and intellectual autonomy. While participants recognized AI's potential for self-assessment and content exploration, they stressed that it must enhance human faculties rather than substitute for mental effort. 3) *Acceleration, Productivity, and Time Management* - AI is perceived as an intense driver of systemic acceleration. Rather than freeing up quality time, its capacity to maximize efficiency often traps students, educators, and professionals alike in a vicious cycle of performance pressure and constant availability, where the machine dictates unsustainable academic rhythms. Reclaiming spaces for pauses, intentional disconnection, and inner listening is identified as an urgent prerequisite to maintaining conscious control over technology. 4) *Communities of Dialogue and Educational Relationships* - A significant barrier identified by students is the tendency to use AI covertly due to a perceived climate of institutional judgment or mistrust. This finding underscores the vital need to foster safe, non-judgmental spaces, interdisciplinary seminars, and shared training pathways where students and teachers can openly analyze the ethical and relational implications of digital tools, safeguarding empathic listening from digital impoverishment. 5) *Critical Literacy, Ethics, and AI-Augmented Education* - Participants expressed a strong demand for an interdisciplinary AI literacy curriculum that extends far beyond mere technical aspects. This framework must integrate psychological, neuroscientific, and ethical dimensions, including a critical analysis of the corporate economic interests driving AI development and the risks of a widening digital divide. Ultimately, both cohorts recognized that the transition is not merely technical, but represents an actual anthropological and neural transformation that demands immediate, aware management and deep ethical questioning. Finally, this evidence converges toward the structural proposal of a conscious, *AI-augmented education* that subordinates technological productivity to the preservation of human well-being, inner competencies, and intellectual freedom. To provide an overview of how these dimensions manifest differently across university cohorts, the specific psychological triggers, operational habits, and perceived risks are contrasted in the comparative matrix in Table 1.

6. Results

The preliminary findings from these focus groups indicate that the adoption of AI in education is perceived not merely as a technical matter, but as a phenomenon that encompasses emotional, cognitive, relational, and ethical dimensions. On the one hand, particularly among students, AI appears as a tool capable of offering immediate support in studying and emotional regulation; on the other hand, there emerges a risk of cognitive and emotional dependency, atrophy of critical thinking, and an excessive delegation of one's own abilities, with potential repercussions on the development of autonomy and trust in human skills. This dynamic often leads students to a form of cognitive avoidance, summarized by the provocative question: "Why bother putting in the effort?". Concurrently, educators and researchers emphasize the necessity of maintaining a *human-in-the-loop* approach, in which AI remains a support rather than a substitute for effort, reflection, and personal processing. For professionals and experts alike, managing the integration of AI requires a strategic investment of time to foster conscious adaptation, effectively guiding AI rather than being driven by it. Academically, institutions must avoid building rigid barriers and ignoring AI's systemic impact on learning communities. From this perspective, participants converge on the importance of promoting spaces for dialogue, critical literacy, and multidisciplinary training, integrating inner skills, ethical awareness, and self-regulation capacities, so as to guide a truly mindful, relational, and well-being-centered use of AI in education. The comparison between the data emerging from the focus groups of the two participant groups highlights

areas of strong convergence, as well as significant interpretative and emotional discrepancies regarding the introduction of AI in educational processes. Table 1 provides a comparative summary of the key dimensions of this phenomenon.

Table 1. Comparative Summary of Perspectives Emerged from the Two Groups.

Dimension of Analysis	***Evidence in the Student Group***	***Evidence in the Group of Educators, Researchers, and Experts***
Prevalent Emotional Experience	Academic performance anxiety; search for safety and a protective relational connection.	Operational frustration; anxiety stemming from work overload and pressure for immediate reactivity.
Relationship with the Machine	Anthropomorphization of the tool; utilization of AI as a therapist or an amicable surrogate.	Necessity of maintaining a *Human-in-the-Loop* approach and safeguarding a mindful presence.
Perception of Effort	Tendency towards cognitive avoidance as a strategy to cope with exam pressure.	Recognition of effort as an irreplaceable neural exercise essential for consolidating logic.
Time Management	Utilization aimed at acceleration and immediate synthesis to demonstrate the acquisition of knowledge.	"Time trap": the more time we save, the more time we remain connected, at the expense of relationships and self-care.
Academic Obstacles	Furtive and hidden use due to the fear of sanctions and moralizing judgment from educators.	Structural difficulty of universities in keeping pace with the velocity of the technological transition.
Proposed Solutions	Creation of sharing groups and horizontal seminars to explore the use of AI in educational contexts.	Transdisciplinary curriculum reform; technical literacy integrated with inner skills.

7. Conclusion

This paper explores a comprehensive, multi-year research programme that started with the *StudentWell* project (2022–2024) and is now being advanced through the ongoing *AI4WellEdu* project. The findings consistently demonstrate that mindfulness-based training effectively cultivates essential inner skills, proving that enhancing internal competencies directly nourishes personal well-being, which subsequently translates into broader societal and academic benefits. Within this cumulative framework, *AI4Well* and *AI4WellEdu* have successfully implemented the *Well-being-Oriented Literacy Framework* applied to AI, presenting an experiential pedagogical methodology that effectively integrates technical expertise with inner development. A key contribution of this research is the mapping of the convergent yet contrasting socio-emotional dynamics among university cohorts. While students frequently turn to generative AI as an emotional refuge to alleviate academic isolation and performance anxiety, academics, researchers, and professionals face extreme systemic pressures to accelerate workflows, navigating professional over-saturation and cognitive overload. For both groups, strengthening an *inner compass* through mindful presence and self-listening serves as an indispensable barrier against cognitive dependency, technological fragmentation, and alienation. Integrating technical literacy with robust inner skills represents one efficient direction for ensuring that the adoption of AI contributes to genuine human well-being. To tackle these challenges in higher education in a practical way, *AI4WellEdu* proposes the following circular, experiential and scalable training framework, structured in two phases, designed to develop both technical and inner skills: 1) *Orientation and Values* - This phase leverages peer-to-peer and intergenerational dialogues between faculty and students to collectively redefine concepts of productivity, creativity, and learning, identifying which uniquely human faculties must be actively preserved. This aligns with the students' demand for a stadial, circular, and participatory approach to seminars on AI use in educational contexts. 2) *Technical and Transdisciplinary Integration.* This phase deploys a co-designed curriculum involving computer scientists, psychologists, pedagogists, and neuroscientists to provide the scientific and psychophysical frameworks needed to safely integrate AI tools into daily study and work routines. Finally, *AI4WellEdu* highlights that the challenges posed by generative AI cannot be solved through restrictive regulations or rigid institutional compliance. Instead, universities must actively promote a paradigm of *AI-augmented education*. By creating structured spaces for pauses, deep listening, and continuous dialogue, the academic community can leverage these powerful technologies to maximize scientific efficiency and creativity while firmly safeguarding

intellectual autonomy, critical thinking, and mental health. To address the risk of social isolation highlighted by the participants, these training programmes must actively promote non-digital interactions and rebuild fundamental interpersonal skills through collaborative teamwork and collective problem-solving.

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An Academic View of Generative Artificial Intelligence Use in Higher Education as Copyright

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Abstract

The purpose of this paper is to present an application of GAI in academic creativity in terms of copyright works like academic courses, academic papers and creative results regarding the copyright in the primary and in the secondary works. The goal is to examine different theses, approaches, and identify unsolved problems and to propose solutions, results of students' acceptance and the general answer of the main question: who's is copyright in the creation of student's works as master thesis and other academic written works through GAI use?
Generative artificial intelligence /GAI/ as a technology based model presents many abilities to students to achieve their academic goals rapidly and efficiency. They use models like LLMs, ChatGPT, open AI and more deep research data bases in their work.
The main questions are raised in this research paper are the following:
- *overall assessment of GAI use in higher education;*
- *who is the copyright owner created with GAI use works.*

In this paper are analysed many questions regarding the copyright owner answered by economics students groups of special course ''Intellectual property and creative industries'' of UNWE.
The complex approach and methods are used by author to present and to prove her author thesis:
A GAI as a machine is not a legal entity, it not an author proprietor of copyright. The student is this individual – an author who creates an idea and implements it with the help of a GAI. The students are responsible for the correct citation and for the volume of the used other's author text, which should not exceed 20-30%.

Keywords: *generative artificial intelligence, higher education, intellectual property and copyright*

Introduction

The field of artificial intelligence was founded in the 1950s, and artists began to create art and literature with artificial intelligence faster and effectively. The main question here is related to the nature of collaboration "human–AI in art and literature"
The GAI boom of the 2020s, text-to-image models such as Midjourney, Stable Diffusion and others became widely available to the public, allowing users to quickly generate imagery with little effort and discussing creativity. Commentary about AI in art and literature in the 2020s has often focused on issues related to copyright, IP deception, its impact on the traditional writers and artists and their rights in the earlier created copyrights works.
This paper is focused on application of GAI in academic creativity in terms of copyright works like academic courses, academic papers and creative results regarding the copyright in the primary and in the secondary works. The goal is to examine different theses, approaches, and identify unsolved problems and to propose solutions.

1. Main Methodological Points

1.1 Review of Different Points

There is no single and simple answer to this question: Who is a proprietor of the copyright?
Two theses are advocated:
1. GAI cannot be a rights holder. Justification: it is a machine trained by computer models to combine databases of copyrighted works of other media, and its creativity lies in skillfully combining known and accessible works through keywords.
2. GAI can be a rights holder.

Supporters of thesis 1 claim and argue as follows:
1.GAI has no legal personality, no rights in IP.
2.GAI is a mashine with software generated and completed by a human.
3.GAI creates an artistic work under idea concept, assignement of manager – human.
GAI working in visual artwork generates through the implementation of artificial intelligence programs, most commonly using text-to-image models. The process of automated art-making has existed since antiquity.
In August 2023, the US Supreme Court ruled that AI art is ineligible for copyright due to failure to meet human authorship. In March 2026, it declined to hear a case over whether AI-generated art can be subject to copyright.

Supporters of thesis 2 claim and argue as follows:
1. AI already creates films, books, drawings.
2. AI has a creative approach and result.
3. AI has autonomy in developing the creative idea and reaches a result.
At first glance, a recently granted South African patent relating to a “food container based on fractal geometry” seems fairly mundane. The innovation in question involves interlocking food containers that are easy for robots to grasp and stack.

I deep observing, the patent is anything but mundane. That’s because the inventor is not a human being – it is an artificial intelligence system called DABUS.

DABUS (device for the autonomous bootstrapping of unified sentience) is an AI system created by Stephen Thaler, a pioneer in the field of AI and programming. The system simulates human brainstorming and creates new inventions. DABUS is a particular type of AI, often referred to as “creativity machines” because they are capable of independent and complex functioning. This differs from everyday AI like Siri, the “voice” of Apple’s iPhones.
Based on the USPTO position ‘’Every patent office and court that has examined the issue so far has ruled that DABUS is not entitled to be named as an inventor on a patent application. But the exercise has raised broader questions about the impact of AI-assisted inventing on the patent system.
You might think the inability to name an AI system as an inventor on a patent application for an invention— created wholly or in significant part by that AI system— implies such an invention can’t be patented at all.
That was the argument made by Lawrence Lessig and others in the amici curiae brief they submitted in the DABUS case before the US Supreme Court: “if… the Court does not recognize AI inventorship, there will be no inventor, resulting in no patent protection, and no technology ownership.”

1.2 Author’s View Regarding AI Use of the Previously Created / Primary Works:

1. The author of a work in literature and art - always is a natural person.
2. The author has the exclusive rights to be named, cited in all forms of use of the work.
3. The use of parts or the whole of the copyrigh works belongs to the author as copyrigh holder and as an options of permission for use. He may authorize others for works use in various modes and purposes.
4. The use of works or parts of them as DB/models in AImust be with the consent of the author. This is not free use in a legal meaning. The author of printed books or art works is also entitled to such remuneration when they are reproduced in a reprographic manner for personal use.
5. Free use, which does not require the consent of the copyright holder and without payment of remuneration, is any of the following actions:

• use of quotations from already published works;
• use of parts of published works for the purposes of analysis, commentary or otherwise for scientific or educational purposes;
• public presentation or performance of published works in schools or other educational institutions;
• reproduction of already published works from libraries, schools, museums and archival institutions, as well as reproduction in Braille.

6. Fair use of a copyrighted work would be when the author of the first work is indicated and remuneration is paid to the rights holders

USA judge Stein concluded that the level of detail in the AI’s response was sufficient to allow the copyright infringement claims to proceed as a class action.

The court will later decide whether OpenAI can defend itself on a “fair use” argument.
Earlier this year, in a similar case, a federal court in San Francisco ruled that the use of copyrighted books by the company Anthropic to train its language models fell within the scope of “fair use.”

2. Case Studies and Questions Discussed with an Audience

2.1 Case Studies

1. “The Day a Computer Wrote a Novel”(2015) – a Japanese short novel partially written by an artificial intelligence program in 2015, the novel was written by a team of humans who developed the AI program. Hitoshi Matsubara and his team at Future University Hakodate in Japan selected words and sentences and set the parameters for the creation before letting the AI robot “write” the novel itself. For the past few years, the Hoshi Shinichi Literary Award has technically been open to non-human entrants. In total, 11 of the 1,450 entries in the competition in Japan were written at least in part by non-humans.

2. „Window Seat“ (2023): Touted as the first fully AI-generated feature film, it is a 61-minute film created by one person (Hooroo Jackson) using 4,000+ machine-generated shots. It follows a narrative about a psychological battle on a plane.This video is the trailer for the AI feature film "Window Seat":



3. George R. R. Martin has won the first battle in his lawsuit against OpenAI for copyright infringement related to his cult series "A Song of Ice and Fire", which is also the basis for the series "Game of Thrones". In September 2023, Martin and several other writers filed a class action lawsuit against the company behind ChatGPT. They claim that OpenAI infringed their copyrights by using their books without permission to train its language models, which, the plaintiffs say, resulted in the generation of texts that resembled their copyrighted works.
4. regarding DABUS: Device for the Autonomous Bootstrapping of Unified Sentience—has been named as the sole inventor. Every patent office and court that has examined the issue so far has ruled that DABUS is not entitled to be named as an inventor on a patent application. But the exercise has raised broader questions about the impact of AI-assisted inventing on the patent system. You might think the inability to name an AI system as an inventor on a patent application for an invention— created wholly or in significant part by that AI system— implies such an invention can’t be patented at all. USA court does not recognize AI inventorship, there will be no inventor, resulting in no patent protection, and no technology ownership.”

2.2 Questions for Discussion

There are a number of other issues arises in the field of copyrights such as following:

1. Which is the content of copyright for already printed literature and art works?
2. How can and may be used legally the copyright works by the students/academians in the training and teaching process ?
3. How we can accept and explain a term "free use" in the case of academic use by students and academians in their works?
4. What are good or bad academic experience?

Students are highly aware that intellectual products created by GAI are intellectual property of others – natural persons, and GAI only combines alreay known achievements and databases/ results.
Analysing the whole list of the students answers following results may present a table bellow:

Table 1.

Q and A	YES – natural person is the author	NO AI is the author	BOTH: human and AI jointly authors	no answer
The author of copyright work, created by AI under idea and created under humans directions	180	12	15	8

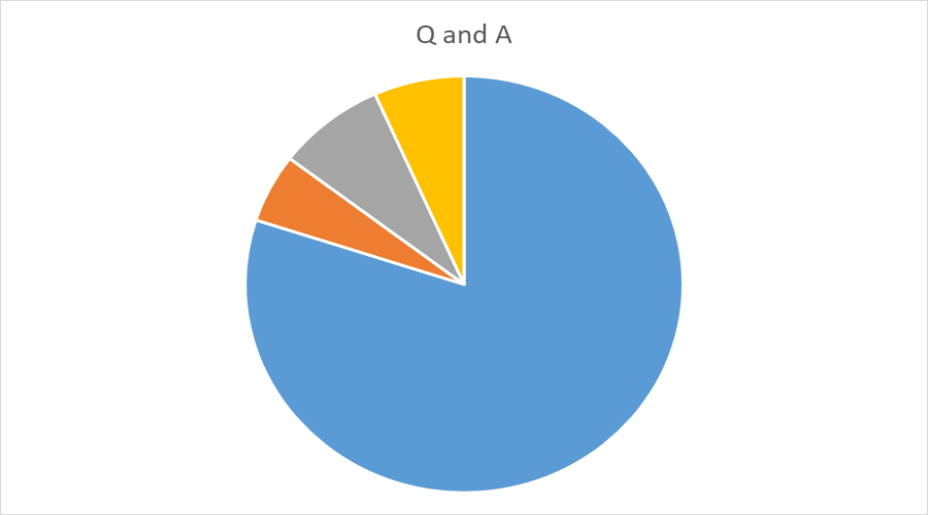


Fig.1. Answers of the question regarding the authorship

More than 85 % of students and academians are awarereness that the author of the created copyright work always is human as natural person.

2.3 Author's Comment:

1. Most AI systems are low-risk models and can contribute to solving many societal challenges.
2. Some AI systems pose risks to personal data and biometrics that you need to address.
3. Draft legislation provides some protection for personal data. Unfortunately, they do not focus on the problems of intellectual propertyand to the specific challenges that AI systems can create in inetllectual property field.

Regulation (EU) 2024/1689 of the European Parliament and of the Council of 13 June 2024 laying down harmonised rules on artificial intelligence – focus: hile ensuring a high level of protection of health, safety, fundamental rights as enshrined in the Charter of Fundamental Rights of the European Union (the 'Charter'), including democracy, the rule of law and environmental protection, to protect against the harmful effects of AI systems in the Union, and to support innovation. This regalation is not regarding to IP rights, CR and related rights.

Conclusions

1. AI has no legal personality, no rights in IP.
2. AI is a mashine with software generated and completed DB by a human.
3. AI creates an artistic work under idea concept, assignment of manager – human.
4. There is a need to form legislation in GAI focused on CR and related to CR.

5. There is a need to disseminate IP culture in areas of creators of software, musicians. artists and writers.
6. The responsibility of the higher education institutions is to teach and train students – future creators and innovators, on IP rights, CR and related to CR.

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A Case Study of EFL Learners' Experiences of Using Interactive Fiction with ChatGPT: A Sociocultural Perspective

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Abstract

This study explored how ChatGPT mediated English as a foreign language (EFL) students' lexico-grammatical development through speaking and writing tasks in Interactive fiction (IF), and how the interaction between learners and ChatGPT with IF tasks changed over time. Sociocultural theory (SCT) framed the analysis and interpretation in this study. The research examined three EFL learners (two aged 20 and one aged 14) who completed IF-designed tasks with ChatGPT. The study lasted four weeks and was conducted within a one-on-one private tutoring context. Data collection tools were ChatGPT logs, semi-structured interviews, class audio recordings, and teacher notes. The data were analyzed inductively through the lens of the SCT theoretical concepts. The study revealed that initial interactional patterns were not aligned with SCT principles. After several iterations, adjusted prompts gradually created learning experiences approximating those considered optimal within SCT. IF tasks also mediated the learning, creating an immersive context for practicing the language. Therefore, the IF tasks with ChatGPT can support EFL learners' lexico-grammatical development through speaking and writing tasks, fostering engagement, self-regulation, and reflection, revealing that ChatGPT can act as a dialogic partner and a mediator within students' Zone of proximal development (ZPD), when the prompt is well-designed. The study also discusses practical pedagogical and methodological implications.

Keywords: *Sociocultural theory (SCT), Interactive fiction (IF), ChatGPT-assisted language learning, English as a foreign language (EFL)*

1. Introduction

From a sociocultural theory (SCT) perspective, language learning is effective when learners are engaged in meaningful social interactions and use language as a tool for communication, rather than as an isolated skill to be developed [1]. Research suggests that IF tasks create a meaningful context for practicing speaking and writing skills. However, to gain fruitful results, learners must be digitally literate, and the task design must be well-structured [2], [3].

Similarly, ChatGPT acts as an IF platform, which, until now, has been realized through specialized websites and apps such as Twine and Inklewriter. Learners make choices, solve problems, and co-construct stories, which enhances engagement and creativity [2], [3]. From the SCT perspective, IF acts as a mediating tool, creating a meaningful context for interaction, encouraging authentic language usage [2].

Unlike these IF tools, ChatGPT is a more flexible system that allows learners to have real-time interactions and mediates the learning process. Nevertheless, it can cause cognitive load, overreliance, and ethical concerns [4], [5]. ChatGPT acts as a mediating tool and a More Knowledgeable Other (MKO), providing feedback and prompts to move learners along their ZPD.

While interactive tasks and ChatGPT are promising tools for language learning, a key pedagogical challenge remains unresolved: EFL learners still lack engaging and structured activities to develop speaking and writing skills, and teachers need guidance on how to design technology-mediated tasks that promote meaningful language use without excessive cognitive load. The literature is promising yet scarce and inconclusive, and there are no studies combining IF with ChatGPT to enhance EFL learners' speaking and writing skills.

2. Methodology

Research Design

SCT has long been used to frame studies on second language development with the help of computer-based and more recent digital tools [15]. It is a theory that explains how humans learn, and how various

tools mediate this process. ChatGPT and IF are examples of such mediating tools. In this study, SCT informed the research methodology as well as the design of IF tasks and ChatGPT prompts to promote meaningful language practice, interaction, and to mediate language learning within students' ZPD. Therefore, SCT addressed "how" ChatGPT, with IF-designed tasks, mediated and scaffolded the language learning process and acted as an MKO within students' ZPD, addressing the following research question: How does ChatGPT mediate EFL learners' lexico-grammatical development through speaking and writing tasks in Interactive fiction?
The theoretical framework and research question required in-depth analysis and explanation of processes, mediation, and meaning-making [6], [7]. A case study design within the online tutoring context and with a small number of participants allowed the researcher to gather deep insights into how the students interacted with IF and ChatGPT-designed tasks [8]. Examining three cases gave a profound understanding of the question that the researcher aimed to address.

Research Participants

The classes were conducted in an online private tutoring context. The teacher-researcher held one-on-one English classes and designed ChatGPT prompts tailored to the students' levels and needs. The lessons took place twice per week via Google Meet and lasted 20-50 minutes.
Three EFL learners participated in the study: Sue (20, B1), Alex (20, B2), and Ani (14, B1). The participants were selected with a maximum variation sampling. Their profiles differed in age, gender, nationality, and language proficiency. Pseudonyms were chosen for the participants. To start the research, the teacher-researcher obtained oral assent. The data were kept confidential following ethical considerations. Only the researcher and supervisor had access to the data, and it was destroyed one month after graduation.

ChatGPT-based IF Tasks

The research aimed to design ChatGPT prompts to create learning experiences for EFL students that approximate the pedagogical principles of SCT to mediate within their ZPD, help them move through other- to self-regulation using ChatGPT as an MKO. Initially, students had three classes with a template that was not in line with SCT. After this piloting period, updated templates were created. They had multiple sections, including the topic, the role for ChatGPT, and the student; six system rules for designing the IF story; task integration and progression; feedback rules; vocabulary rules; and pedagogical requirements.
ChatGPT acted as an EFL instructor and an IF story generator through the lens of SCT. The task progressed from shared to independent performance. The language difficulty of the narrative was based on the participant's language proficiency. Moreover, the student's gender and age were also mentioned to generate relevant texts. The branching narrative had two story paths, and the tasks alternated between speaking and writing tasks. The feedback was also changed throughout the classes from explicit to implicit.

Data Collection and Analysis

After piloting, ChatGPT prompts were redesigned. The data collection lasted four weeks. Participants completed four classes with an updated ChatGPT template. From the initial number of participants, these three individuals were selected based on certain criteria such as age and gender. Classes lasted 20-50 minutes and included post-task semi-structured interviews. Moreover, tasks were audio-recorded for later analysis and redesigned for each participant. The data was collected from ChatGPT logs, semi-structured interviews, teacher notes, and class audio recordings.

3. Results

What follows below are the findings presented as themes that emerged throughout the study.

3.1 Designing Mediation

First, all classes had the same structure, and ChatGPT guided students by introducing six scenes, A/B story paths, task instructions, and two reflective questions. Throughout the classes, the predictable task structure alternated between speaking and writing tasks, helping students reduce cognitive load and

focus on the story creation rather than the structure of the tasks. This did not happen after the first class. All three participants needed time to internalize the structure. After the preparation period, the teacher's notes confirm that students took control of the tasks, even ignoring reading the instructions, completing the tasks quickly, and automatically alternating between speaking and writing tasks. This type of task design structure and instructions align with SCT viewing them as mediating tools that promote goal setting, language learning, and thinking. Moreover, students' behavior became self-regulated over time, showing that the mediating tools were internalized [7]. Second, another type of regulatory mediation was the type of feedback that guided and controlled the learning. The feedback was changed throughout the classes for all three participants.

Class 1
The feedback was designed to provide graduated feedback after each scene. However, ChatGPT corrected mistakes explicitly. With this prompt, ChatGPT was not natural at providing SCT-informed feedback and mediation, and students heavily relied on other-regulation. For example:
Sue: I always did my tasks on the right time.
ChatGPT: I always did my tasks on time" is more natural than "on the right time [21].

Class 2
For the second class, the prompt was adjusted to remove feedback after each scene. The students received final feedback, which identified 4-5 priority areas of improvement, and encouraged them to reflect. For example, Alex confused "fun and funny, satisfied and satisfying" in class 2. After completing all the scenes, ChatGPT corrected the student's mistakes explicitly and, for enhancing vocabulary, suggested, "You sometimes use adjectives in unnatural combinations (e.g., funny and satisfied trip → better: fun and satisfying trip) [21].
Providing feedback at the end of the task allowed students to perform without interruption, revealing students' ZPD, what they could do alone, and what help they needed. Although the feedback was delayed and it was provided when the students completed all the scenes, the chatbot provided correct answers, instead of supporting the student in co-constructing knowledge, which was not consistent with SCT. Thus, ChatGPT was still unable to provide gradual and contingent mediation in error correction.

Classes 3-4
ChatGPT gave final feedback after scene 6. The chatbot gave implicit error correction, asked guiding questions to explore, notice mistakes, and self-correct. For example:
ChatGPT: Verb Forms & Tense. You wrote: "When i finally reach the spectacular viewpoint, and saw…" Hmm… "reach… and saw…?" Do the two verbs match the same time? Can you check which tense you want for both? Try correcting that part. Just the verb forms, not the whole sentence [21].
Sue: 1- reached, saw
ChatGPT: Verb Forms: You wrote: "reached, saw" These look like the correct forms, but think about how they fit into your full sentence: "When I finally reached…, and saw…" The pair looks good — just check: Do both verbs follow the same pattern in that sentence? Does anything feel missing before "saw"? Take a quick look at your sentence and see if you want to adjust anything.
Sue: When i finally reached the spectacular viewpoint, i saw that illustration in front of me i felt like i own the city.
Aligning with SCT principles, ChatGPT acted as the MKO and asked questions within ZPD to help them find out the correct answer themselves, notice, rethink, internalize forms, and move from other- to self-regulation [7], [9]. Here, the feedback mediated thinking rather than providing correct answers, and ChatGPT guided the students to fix mistakes. Therefore, the teacher was able to redesign the prompt so that the mediation came proximate to SCT expectations. This approach for feedback supports the graduated and contingent mediation suggested by [9], where the support is adjusted and removed according to the students' language development and autonomy. ChatGPT's error correction improved, but it tended to be verbose, which could disempower students and leave less room for autonomous exploration. For example, teacher notes confirmed that Alex's behaviour sometimes revealed that he did not want to read the feedback because he scrolled up and down to see the length of the feedback, and said, *"I think it's end?"* However, he did not stop the class and continued interacting with the chatbot to fix errors, after the teacher's instruction, *"Let's correct the mistakes."* The other students also shared their opinions about the feedback during the interview. They said that the guiding questions were more useful because they helped think, explore correct forms, and remember better. In addition, Ani reflected that the feedback at the end of the tasks did not distract from thinking of the story creation. There were cases when students did not know how to correct mistakes. They fixed errors through the

teacher's mediation. For instance, Ani, during Class 3, was able to understand her mistake, *"a good advice"* only after the teacher's guiding questions, *"Is advice an uncountable or countable noun?", "Should you use article "a" with uncountable nouns?"*
These findings also revealed that prompt design shaped the quality of mediation, promoting SCT-aligned learning experiences, mediating the students' lexico-grammatical development through speaking and writing tasks, regulating the interaction, and structuring students' activity [7]. ChatGPT acted as a regulatory mediator whose support guided students in the early stages, and later it was internalized by the students [7], [9]. This suggests that for the prompt to function effectively for ChatGPT, careful, SCT theory-driven prompt engineering is necessary to advance noticing, reflection, and help students go through other- to self-regulation. Therefore, the teacher's role remains central in designing and testing the prompt to ensure the chatbot provides developmentally appropriate mediation within students' ZPD.

3.2.1 Lexical Mediation

ChatGPT used the target vocabulary mentioned in the template in the story scenes and paths. This promoted noticing and internalization of vocabulary. Moreover, ChatGPT recycled the words throughout the scenes, which gave students a chance to reuse the words in various contexts and recycle the vocabulary. These results demonstrated that ChatGPT mediated vocabulary development, providing the vocabulary in the story scenarios and paths, encouraging the students to use the same words in different situations. According to [10], this promotes noticing, retrieving, and developing lexis. Additionally, this supports SCT principles, highlighting that recycling of vocabulary shows how mediation works in the ZPD [7], [11]. Moreover, this finding aligns with previous research [2], [3], suggesting that well-designed digital stories create meaningful environments and individual experiences to practice and develop vocabulary. However, students did not fully master the target vocabulary. For example, Participant 2 confused "fun and funny, satisfied and satisfying" in class 2. Participant 1 did not use "commitment, and getting things done" in class 2. Participant 3 did not use "embarrassed, exhausted, annoyed, annoying, relaxing, satisfied, satisfying" in class 1. The results demonstrated participants' lexical strengths and weaknesses, and this is consistent with the principles of dynamic assessment, showing what the learners can do and where they need more assistance [9]. Therefore, ChatGPT mediated students' vocabulary development within their ZPD, integrating what the students already know and pushing them to expand their word stock. This aligns with SCT principles of viewing the language as a tool for thinking and an object for learning new vocabulary [11].

3.2.2 Grammatical Mediation

The analysis of four classes revealed inconsistent findings on grammar development. However, students benefited from different types of corrective feedback and demonstrated micro-level self-regulation and internalization. ChatGPT's error correction evolved from explicit to delayed and implicit feedback. Aligning with SCT principles, ChatGPT did not initially provide graduated feedback supporting students in moving from other- to self-regulation. Providing delayed feedback at the end of the task allowed students to perform independently. The students came up with longer and more complex ideas, showing developmental patterns in grammar. This type of error correction revealed what forms are internalized, and what areas need improvement [12]. When the prompt was adjusted to change from explicit to implicit feedback, ChatGPT acted as the MKO and asked questions within the students' ZPD to help them find correct answers, rethink, internalize the forms, and move from other- to self-regulation. Nevertheless, teacher-researcher notes also stated that when the participants did not know the correct form, they did not know how to correct the mistakes. They relied on the teacher's or the chatbot's help, so the teacher or ChatGPT continued explaining and guiding the students to fix the mistakes. This aligns with the principle of graduated assistance that the less explicit error correction is effective when the students are ready and independent enough to take control of it [9]. To sum up, although the findings were not consistent, there were cases of micro-level self-correction through ChatGPT's mediation. Moreover, the teacher also mediated during implicit error corrections, helping the students understand and fix errors. Therefore, ChatGPT mediated cognitive-linguistic skills such as micro-level self-correction, reflection, and reasoning despite uneven grammar development.

3.3 Metacognitive Mediation

Findings revealed metacognitive mediation through reflective questions, guiding students to rethink their choices, expand their speaking and writing, and show more awareness of their decisions. The template

of the task involved two reflective questions after scenes 2 and 4. These questions align with SCT's conceptualization of metacognitive mediation, which guided the participants to explore "why" in their choices, promoting deeper thinking, reflection, and evaluation. This mirrors one of the ideas of SCT that advanced thinking is firstly mediated by others, then it slowly becomes self-regulated [7], [11], [13], [14]. Sue and Ani's responses demonstrated that ChatGPT can be used as a digital environment for metacognitive reflection to expand spoken and written replies. These results also support recent studies that AI functions as a mediation tool, promoting higher-order thinking and learner autonomy [15], [16], [17]. For Alex, reflection questions in classes 3 and 4 were embedded with the story instructions, and he overlooked them. However, he justified the answers, showing awareness of his choices. This shows that the task was not well designed to make the questions visible. These findings are in line with the research on Interactive fiction and AI tools, stating that the students want to reflect and have analytical talk when the questions function well, they are clearly separated from other tasks, and when they are noticeable [18], [2], [19].

3.4 Interactive Fiction as a Mediator: Affective and Motivational Dimensions

Another type of mediation that was revealed by analyzing the results is affective mediation. ChatGPT interacted with a friendly tone, which reduced anxiety and stress, making students feel comfortable and motivated to produce the language. The praise words in the feedback helped students be more confident about their answers. However, in some cases, students ignored reading the praise words to focus more on continuing and creating the story. Moreover, Interactive fiction stories themselves mediated the learning, creating an engaging context for students to speak or write about their own paths. Interviews and teacher notes indicate that participants were emotionally immersed, imagining that they were experiencing those moments in real life. According to SCT, symbolic and cultural artifacts, such as narratives, also mediate language learning, showing how the learners feel, think, and use the language [7], [14]. In this study, Interactive fiction tasks created a meaningful context that helped the participants to be immersed in the story creation process, to imagine the scenes, experience various emotions, and show problem-solving, risk-taking, reflecting, reasoning, and management skills. All of this contributed to the willingness to produce the language and enhance their speaking and writing skills within their ZPD. Students did not use the language mechanically. Additionally, story paths made the story creation more personalized. Students made decisions, gave reasons, examples, and reflected, which promoted higher-order thinking and more extended responses. In addition, they internalized the task design by skipping reading the instructions and choosing to read or to listen to the chatbot's input independently. These findings align with previous research, indicating that IF tasks foster engagement, autonomy, and create an environment for purposeful language use [18], [2]. In conclusion, affective mediation was shaped by Interactive fiction stories, ChatGPT's friendly tone, personalized, and choice-driven responses. These elements reduced stress and encouraged students to participate in the tasks and produce language within the ZPD. However, students sometimes skipped reading ChatGPT's praise words, showing that the chatbot's affective mediation sometimes had a secondary role.

3.5. From Dependent to Independent Task Performance

The results show how participants went through other- to self-regulation, becoming more independent, confident, and using complex sentences. These findings line up with Vygotsky's ZPD and the principles of graduated and contingent mediation, explaining how this transition happened.
Earlier: All participants relied heavily on ChatGPT's prompts during the first preparation class. They were not confident and read everything carefully. Moreover, students kept asking questions to make sure they were doing everything correctly. Class recordings revealed these questions, for instance, *"Should I read the task? Should I say now or record first? Should I read now? How should I start it?*
"Should I listen or read?"
Later: Over time, they became more engaged and confident, producing longer and more complex sentences without asking questions about the task structure, and feeling more independent. Students did not read the instructions and completed them quickly. Teacher-researcher's notes show participants skipped instructions during the last two classes and immediately produced their answers. Therefore, these findings demonstrate how students went through other- to self-regulation by internalizing the structure of the tasks [11].

3.6 Summary of the Findings

The study addressed the following research question: How does ChatGPT mediate EFL learners' lexico-grammatical development through speaking and writing tasks in Interactive fiction? ChatGPT failed to provide mediation independently. The teacher redesigned the prompt for ChatGPT to function according to SCT-like principles. Consequently, ChatGPT functioned as the MKO that mediated the learning process with minimal teacher intervention. IF tasks also mediated the learning, creating a meaningful context for the participants to practice the language. From an SCT perspective, these findings demonstrated that IF and ChatGPT's mediation shaped students' lexico-grammatical development through speaking and writing tasks.

The language, ChatGPT, and IF stories were cultural and symbolic tools that students used to process and express ideas, plan, and evaluate. In line with Vygotsky's view of language as the main tool for thinking, ChatGPT acted like a dialogic partner engaging the students in meaningful conversations, promoted noticing, and encouraged them to reformulate responses and elaborate on them [7], [14], [11]. In this regard, students' lexico-grammatical development through speaking and writing tasks can be seen as the growth within their ZPD. Tasks were appropriate for the students' language proficiency. The students gradually demonstrated internalization, self-regulation, confident production, and application of more complex structures without hints. Aligning this with previous SCT research, it comes to light that first, higher-order mental and language skills are developed from interaction with tools or people, and later these skills are internalized by an individual over time [13], [15]. Therefore, the findings demonstrate that when properly designed, ChatGPT prompts integrated with IF can facilitate the lexico-grammatical development through speaking and writing tasks according to SCT principles.

Over time, the students started answering with more detailed and complicated sentences, although they made mistakes in their replies. This shows that the students were working within their ZPD, stretching their skills with the help of IF and ChatGPT's mediation to take risks and use complex sentences [20]. The shift from explicit to implicit error correction is in line with graduated and contingent mediation that the support should be changed according to the students' needs and removed when they show progress [9]. Thus, the interactional changes show internalization of language and task structure, which is aligned with SCT principles that development happens when the students repeatedly do mediated and meaningful tasks until they can handle them alone.

To sum up, the findings demonstrated that ChatGPT with IF tasks and SCT lens supported the EFL learners' lexico-grammatical development through speaking and writing tasks, and promoted engagement, self-regulation, and reflection. Moreover, if the prompt is well-designed, ChatGPT can act as a dialogic partner and a mediator within students' ZPD. As a result, this study supports the integration of AI in language learning to enhance EFL learners' language development, technology literacy, autonomy, and engagement.

3.7 Pedagogical Implications

The findings suggest implications for EFL teachers, curriculum designers, educational institutions, and other practitioners to integrate IF tasks with ChatGPT into language teaching. First, storylines with branching plots (A/B options) encourage decision-making and reasoning. Then, ChatGPT's mediation was contingent on how the prompt was designed to function as an MKO and mediate learning within the students' ZPD. The prompt included the following sections: ChatGPT's role, IF structure, task design and progression, language focus, feedback principles, and mediation rules. Therefore, the prompt design should be viewed not only as providing technical instructions to the chatbot, but also as part of the pedagogical process, similar to how teachers sequence tasks and scaffold the learning. This study suggests an SCT-aligned prompt design to practice lexico-grammatical features through speaking and writing tasks while completing IF tasks with ChatGPT. Next, the students benefited from graduated feedback. Provide an example of the format you expect for implicit feedback in a prompt. In this study, ChatGPT frequently misinterpreted the concepts of "implicit/explicit" feedback when an example was not provided. Practitioners may apply this type of feedback because it helps students go through other- to self-regulation and promotes internalization of the forms. Moreover, teachers, curriculum designers, and educational institutions can adjust the prompt to make the reflective questions more visible. This allows the students to rethink their choices, feelings, and elaborate their responses, showing reasoning and deep awareness of their choices. Then, teachers and curriculum designers can intentionally add recycling of the target vocabulary throughout one class. This supports noticing, internalization, and retention of the vocabulary. Each task should include a lexical or grammatical component, avoiding excessive demands and instructions that cause cognitive load, and adjusting the language difficulty

according to the students' proficiency. Next, students benefited from a fixed task structure and design. Teachers can follow the same approach because this reduces cognitive load, anxiety, and stress, helping students to be focused on producing the language and creating meaning. Moreover, storytelling can include visual cues to promote engagement and comprehension. Additionally, in larger classes, interactive reading can be assigned as shared homework in ChatGPT, for students to create groups in the bot and collaborate on storytelling and reporting. Finally, the interaction between students and ChatGPT will be successful when the participants are aware of ChatGPT's features. The teacher-researcher conducted an introductory session on IF and ChatGPT, which fostered the students' literacy in the topic and the tool. Practitioners can follow the same approach to ensure students have basic knowledge of the topic.

3.8 Limitations

One major limitation is that ChatGPT did not mediate learning independently. The effectiveness was contingent on human pedagogical input and revised prompts. As a result, ChatGPT cannot be considered an independent MKO, since the effective mediation was co-constructed through teacher intervention. The study also tracked how learners gradually shifted from other- to self-regulation over four weeks of completing IF tasks with ChatGPT, allowing the observation of developmental changes at a micro-level. However, as the study lasted for a limited period, it restricts insights into longer-term processes of internalization.

Although IF acted as a mediating cultural artifact, fostering engagement and meaning-making, its narrative format also imposed limitations. In some cases, complex storylines, overly detailed feedback, or embedded reflective questions increased cognitive load, distracted students from focusing, because learners had to think about too many things at once. This finding underscores the story's dual function as a mediator that can both facilitate and constrain learning, a distinction that was not explored in this study. While affective mediation could be identified based on learners' interaction with the chatbot, engagement, interview answers, and behavioral indicators, ChatGPT could not perceive non-verbal cues such as hesitation, silence, confusion, or facial expressions. In several cases, when ChatGPT failed to recognize emotional states, learners required the teacher's mediation. As a result, AI-mediated interaction alone cannot fully represent or manage affective regulation and emotional dimensions of the ZPD.

3.9 Recommendations for Future Research

Based on the study's findings and limitations, this section recommends future research to focus on the amount and timing of feedback, which may cause cognitive load and weaken the mediation effect. Moreover, delayed or immediate feedback may have a significant influence on how students notice and internalize feedback. Other theories may shed more light on these issues, such as Cognitive Load Theory (CLT) or Multimedia Learning Theory (MMLT), which provide more explicit accounts of how the amount and timing of feedback impacts learning outcomes in digital contexts and students' cognitive processing. Finally, future research should also focus on the use of affective mediation. Praise emerged in the data, but there was limited scope to explore it in more depth within the focus and SCT framework. As praise was often ignored, this indicates that affective support should be studied in terms of its impact on learners and learning, rather than its presence.

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The Role of Artificial Intelligence in Promoting Accessibility for Students with Disabilities: The Landscape of Inclusion in Vocational and Higher Education

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Abstract

The inclusion of students with disabilities in Vocational and Technical Education (VTE) faces challenges that go beyond physical barriers and encompass communication and pedagogical limitations. This research investigates the potential of Artificial Intelligence (AI) and digital technologies as strategic tools to promote accessibility at the Federal University of Santa Maria (UFSM). The research was motivated by the need to overcome the still-nascent adoption of these technologies in educational institutions, with a view to the ethical and critical training of teachers and the empowerment of students with disabilities. The central objective was to investigate and systematise innovative pedagogical practices that utilise AI technologies to personalise educational support and adapt content to students' specific needs. Methodologically, the research adopted a mixed-methods (quantitative and qualitative) approach of an exploratory-descriptive nature. Data collection involved a population of approximately 800 students with disabilities (physical or motor, visual, hearing, intellectual, multiple, ASD (autism spectrum disorder), high abilities or giftedness, fibromyalgia and similar conditions) studying at the EPT at UFSM, of whom 45 participated. In the quantitative part, as of December 2025, we characterised the initial landscape of the use of Artificial Intelligence (AI) resources and other digital technologies to promote accessibility for people with disabilities or specific educational needs in Professional and Technological Education and in Higher Education at UFSM. The data reveal low adoption and limited awareness of Artificial Intelligence (AI) tools among respondents. The majority state that they do not use, or have never heard of, specific applications for academic support, such as chatbots, literature review tools, writing assistants, tools for creating visual content and presentations, or tools for adapting teaching materials to improve accessibility. A lack of, or very low, knowledge of the subject predominates, with frequent responses indicating a lack of prior reflection on the impact of AI on accessibility. The study highlights a critical need for digital literacy and institutional support, bearing in mind that, whilst this research aligns with the Sustainable Development Goals (SDGs 4 and 10), it also reinforces the commitment to equity and social justice within the academic environment.

Keywords: *Accessibility; Artificial Intelligence; Digital Technologies; Inclusion.*

1. Introduction

In the last three years, the rapid integration of Generative Artificial Intelligence (GenAI) in education has moved from a peripheral curiosity to a central systemic challenge. Since the public release of Large Language Models (LLMs) in late 2022, the educational landscape has faced an unprecedented disruption. The democratisation of Artificial Intelligence (AI) has facilitated access to the production of digital resources and the automation of processes across multiple sectors, including education. The rapid diffusion of a technology with such profound impact has revealed the need for a regulatory framework, but has also raised fundamental ethical questions about its application: where, how, and with what meaning and limits can or should AI be used? International organisations, such as UNESCO, have defined core principles for the responsible use of AI, while the European AI Act has established legal safeguards to protect citizens from abusive uses by companies and institutions.

For students with disabilities in Vocational and Technical Education (VTE), this disruption presents both a risk of further marginalisation and a transformative opportunity for inclusion. In this research, we believe we should take advantage of the opportunities it may offer, while minimising the risks that still haunt its use, usually among certain special audiences.

The inclusion of students with disabilities remains a multifaceted challenge that requires integrated approaches involving effective public policies, innovative pedagogical practices, and the strategic use

of assistive digital technologies. Despite institutional advances, barriers related to communication, pedagogy, and technology persist, compromising the access, retention, and academic success of these students. Data from Portuguese and Brazilian higher education institutions reveal that dropout rates among students with disabilities exceed the general average, largely due to limited digital accessibility and insufficient pedagogical support.

AI is rapidly transforming education, but its effective integration depends less on the tools themselves and more on pedagogical clarity, assessment redesign, and human-centred competencies. This research examines the potential of AI and other digital technologies as strategic tools to promote accessibility at the Federal University of Santa Maria (UFSM). It aims to investigate and systematise innovative pedagogical practices that use AI to personalise educational support and adapt content to specific needs. Furthermore, it seeks to contribute to future teacher training guided by ethical and critical principles, aligning with Sustainable Development Goals (SDGs) 4 and 10 to promote equity and social justice in the academic environment.

2. Theoretical Background

AI has rapidly evolved from a set of specialised computational techniques into a pervasive socio-technical infrastructure shaping how individuals learn, work, and interact, with recent advances in GenAI marking a shift from passive consumption of digital content to active, large-scale production of knowledge, media, and services. Across society, AI systems are embedded in domains such as healthcare, finance, transportation, research and education, enabling data-driven decision-making, personalisation, and automation, while also raising critical ethical, bias, transparency, and digital inequality concerns.

In the educational sphere, AI is increasingly aligned with the principles of Inclusive Education and Universal Design for Learning, supporting more flexible, adaptive, and accessible learning environments. For students with special educational needs, particularly those with visual, auditory, cognitive, or motor impairments, AI-powered tools such as intelligent tutoring systems, speech recognition, text-to-speech, computer vision, and real-time captioning are transforming access to content and participation in learning activities. We can also highlight persistent challenges, including the need for robust evaluation of accessibility outcomes, teacher training, ethical safeguards, and equitable access to AI technologies, ensuring that their transformative potential effectively reduces, rather than reinforces, educational disparities.

2.1 The Evolution of AI in Educational Contexts

The integration of AI in education is fundamentally aimed at facilitating personalised learning experiences. By leveraging data-driven insights, AI tools can identify a student's specific knowledge gaps in real time and provide tailored resources, enabling them to progress at their own pace. Historically, educational technology focused on digitised content and learning management systems; however, the shift toward GenAI marks a transition from "tools for consumption" to "tools for production," as Sarah Wang and Shangda Xu discuss on the Andreessen Horowitz (2024) website [1].

The evolution of AI in education can be understood in three overlapping phases [2]:

- Reactive AI and Chatbots (2021-2023): Characterised by the mass adoption of models used primarily as conversational search engines, with a focus on academic integrity and cheating.
- Contextual Generative AI (2024-2025): Introduced Retrieval-Augmented Generation (RAG), enabling institutions to ground AI responses in verified data and mitigate issues such as "hallucinations".
- Agentic AI (2026-Present): AI agents capable of executing complex sequences of tasks, autonomously planning curriculum units, and monitoring student progress in real-time.

But it is commonly accepted that AI should not drive pedagogy; pedagogy should guide AI use. Reflective practice is essential. Short, iterative reflections on classroom AI use help teachers build context-specific evidence and develop metacognitive awareness, which is more valuable than relying on external claims about tools. Additionally, it is estimated that a strong consensus rejects AI detection tools as unreliable and unfair [3]. Instead, the literature emphasises: (i) process-based assessment; (ii) authentic and oral evaluation; (iii) reflection and transparency in AI use. Frameworks such as the AI Assessment Scale [4] and the “third path” approach [5] propose scaffolded AI integration, in which use is permitted but bounded by learning goals. So, we should be able to understand why we use a particular AI platform or tool, why we chose it over alternatives, the learning goal it serves, and how it strengthens the way you already teach the lesson. In other words, as we move into the era of Agentic AI, the focus

must remain steadfastly on pedagogical intentionality rather than technical capability. By prioritising reflective practice and process-based assessments, educators can go beyond AI detection and move toward gradual integration.

2.2 Pedagogical Framework: I-TPACK

Traditional models like TPACK (Technological Pedagogical Content Knowledge) focused on the intersection of content and technology. The emergence of AI requires a new dimension: Intelligent-TPACK (I-TPACK), which integrates ethical knowledge and algorithmic literacy into the teacher's core competencies [6].
The transition from TPACK to I-TPACK signifies that technological proficiency is no longer enough; educators must now possess algorithmic discernment. This new layer of "Intelligent" knowledge requires a shift in the teacher's role from a consumer of educational software to an auditor of automated logic. Teachers must now understand how algorithms process information to avoid bias and ensure that AI-generated feedback is pedagogically sound. It involves not only knowing how to use an AI tool but also understanding the underlying data structures that may inadvertently marginalise specific student cohorts. Consequently, professional development must evolve to include ethical troubleshooting, ensuring that when AI acts as an intermediary in the classroom, it does so through a lens of equity and pedagogical rigour that only a human educator can provide.
Furthermore, literacy in the age of AI is being redefined as the ability to navigate "digital plastic" [7], the malleable nature of AI-generated content, where the human role is that of a critical curator and editor. The concept of "digital plastic" highlights a fundamental change in our relationship with information. Because AI-generated content is inherently fluid and prone to hallucination, the modern educator acts as a critical gatekeeper, transforming raw machine output into reliable instructional material. This is particularly vital for inclusive education, where the stakes of AI adoption are highest. While the potential for AI to automate accessibility, such as real-time captioning or text simplification, is immense, its current underutilization underscores a critical implementation gap. Bridging this gap requires moving beyond viewing AI as a productivity shortcut and instead embracing it as a highly malleable scaffold that, when curated correctly, can dismantle traditional barriers to learning.

2.3 The Responsible Use of AI in the Educational Context

In the European Union, the main framework comprises documents such as the European Commission's Ethical Guidelines on the use of AI and data in teaching and learning for educators [8], as well as the broader legal framework of the EU AI Act [9]. The educational guidelines (2022, updated in the context of the Digital Education Action Plan) focus on the ethical use of AI by teachers and institutions, promoting principles such as transparency, data protection, fairness, inclusion, and the development of students' critical thinking. These guidelines offer teachers practical support in integrating AI pedagogically, ensuring that students understand both the potential and the risks of these technologies. Complementarily, the AI Act establishes a risk-based legal framework, classifying AI systems and imposing stricter requirements for high-risk applications – including some used in education (e.g., automated assessment). The European model is based on the idea of "trustworthy and human-centred" AI, balancing innovation with fundamental rights, safety, and accountability.
The Framework for the Responsible Development and Use of Artificial Intelligence in Education, developed by the Brazilian Ministry of Education (Ministério da Educação do Brasil) [10], provides a vital framework for institutional policies in Brazil. It emphasises that while AI offers opportunities for efficiency, it poses risks of "metacognitive laziness" and requires a fundamental reconstruction of the teacher's role. Responsible use involves ensuring that technologies promote equity and do not reinforce existing social and educational inequalities. This framework establishes guidelines to support the ethical, safe, and inclusive adoption of AI in Brazilian educational systems. The document acknowledges the transformative potential of AI to personalise learning, support educational management, and expand access to education, while emphasising that its implementation must align with principles such as equity, transparency, privacy, data protection, and respect for human rights. It also highlights the importance of ensuring that AI does not deepen existing inequalities and of promoting accessibility and inclusion, particularly for students in vulnerable situations. Furthermore, the framework underscores the need for continuous training for teachers and school leaders to foster critical, pedagogically grounded uses of AI and to develop digital and ethical competencies. It also proposes adopting governance, evaluation, and monitoring mechanisms to ensure the quality and contextual appropriateness of AI technologies used in education. Finally, the document stresses the importance of collaboration among government,

academia, the private sector, and civil society to promote responsible innovation focused on student well-being and the improvement of teaching and learning processes.
In Portugal, there isn't an "AI education framework" as specific as in Brazil, but there is the national AI Portugal 2030 strategy, which frames the development and use of AI in various sectors, including education [11]. This strategy strongly emphasizes the qualification of the population, digital literacy, and AI training from basic levels to higher education, recognizing education as a central axis for the country's digital transformation. On the ethical and social level, the document also highlights principles such as inclusion, equity, transparency, and respect for fundamental rights, aligning with the European model. It also promotes lifelong learning, professional retraining, and collaboration between academia, the public and private sectors, with the aim of preparing citizens and institutions for a responsible and sustainable use of AI, including in the educational context.
In short, the European Commission presents a normative approach with ethical guidelines, i.e., a strong regulatory component (AI Act). From this perspective, Portugal follows a strategic approach (capacity building, education and innovation), while Brazil follows an applied educational framework, with a direct focus on pedagogical practice.
Being more pragmatic about ethical and responsible use of AI in academic work, guidelines across sources converge on three principles: (i) transparency (disclosing AI use); (ii) process documentation (keeping interaction logs); and (iii) reflection (evaluating AI's impact on learning). These approaches shift the focus from policing to pedagogical accountability [12].

3. Materials and Methods

The research adopted a mixed-methods, exploratory-descriptive approach using both quantitative and qualitative data. The field of study was the UFSM, a Brazilian federal university in Santa Maria, Rio Grande do Sul.
Data collection involved a population of approximately 800 students with disabilities at UFSM from November 27th to December 26th, 2025. This population includes individuals with physical or motor, visual, hearing, intellectual, and multiple disabilities, as well as those with ASD, high abilities/giftedness, and fibromyalgia.
A digital questionnaire was the primary instrument for collecting data, including questions on AI awareness, the frequency of use across various AI categories (e.g., chatbots, literature review, writing assistants), and ethical concerns. The survey also explored the use of assistive technologies with and without AI.
A total of 45 students participated in the quantitative phase, even though they were finishing their classes and were near the Christmas and Summer holidays. This convenience sampling, or accessibility sampling, is a non-probabilistic method that allowed participants to be selected based on their immediate availability and ease of access for the researcher. The small, non-probabilistic sample size (n=45 out of ~800) limits the generalisability of the results, but does not invalidate the exploratory value of the study.
The graphic of Fig. 1 refers to the level of education of the respondents: 5 students (11,1%) are Integrated secondary education (Vocational and Technological Education); 4 students (8,9%) Technical course (Vocational and Technological Education); 23 students (51,1%) Undergraduate degree (Higher Education); and 13 (28,9%) are Postgraduate degree (Higher Education).

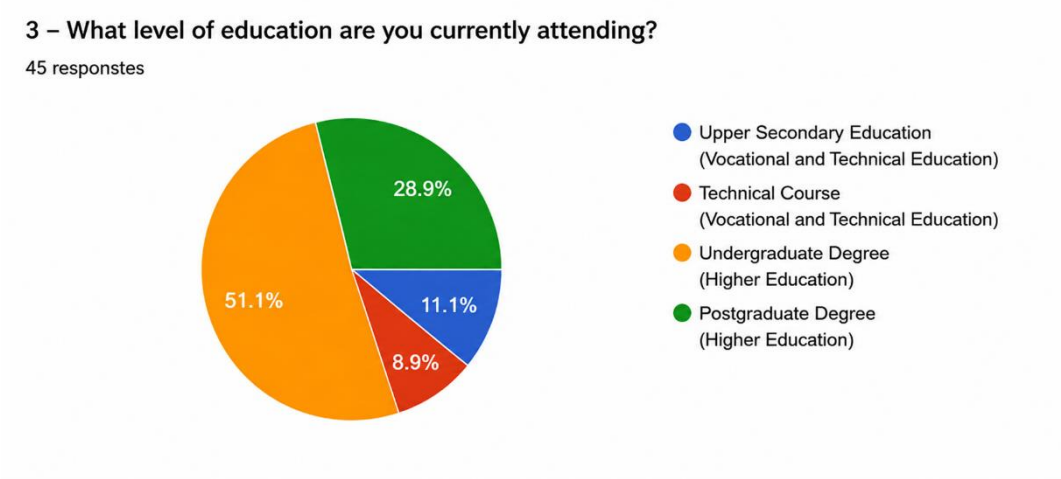


Fig. 1. Level of education of the respondents

The quantitative data were analysed to characterise the initial landscape of AI use for accessibility as of December 2025. This involved assessing adoption rates, familiarity with specific tools like ChatGPT, Gemini, and Canva, and the perceived impact of AI on student autonomy.

4. Results

Generally, the data collected from UFSM students reveal a landscape characterised by low adoption and limited awareness of AI tools specifically designed for accessibility and academic support.
Although 95.6% (43 students) had heard of AI and 73.3% (33 students) had already used some AI-based tool or application, only 4.4% (2 students) admitted to having advanced knowledge, 22.2% (10 students) intermediate knowledge, and 57.8% (26 students) basic knowledge about AI and its applications. Even so, 15.6% (7 students) admitted to having no knowledge whatsoever.
The most common types of activities performed using AI tools were: (i) obtaining answers to relatively simple questions (23 students (51.1%)); (ii) searching for and summarizing articles (19 students (42.2%)); (iii) generating images, graphs, or diagrams (17 students (37.8%)); and (iv) creating presentations (13 students (28.9%)).
Regarding the use of AI tools (chatbots and search assistants), despite their low frequency, they are the most used. All other categories of suggested AI tools (tools for searching and reviewing literature; for academic writing and editing; for presenting and creating visual content; for extracting information and interacting with documents; for learning and organising knowledge; or even for creating activities that meet inclusion and accessibility requirements) showed non-use or lack of awareness rates above 66.67% (30 or more out of 50 students).

Table 1. Frequency of AI Tool Usage among UFSM Students with Disabilities

Tool Category	Most Common Response	Tool most used
Chatbots & Research Assistants	Frequently	Gemini
Literature Search & Review	Rarely	Perplexity AI
Writing & Academic Editing	Rarely	Grammarly
Data Analysis & Visualization	Never	---
Visual Content & Presentations	Rarely	Canva and Gamma AI
Accessibility & Inclusive Adaptation	Rarely	paracasainclusivo.com.br

(0) Never, (1) Rarely, (2) Sometimes, (3) Frequently, (4) Always when I need

Key findings from the quantitative survey include:

- **Awareness vs. Depth:** While most students have heard of AI, their level of knowledge is often classified as "Basic" or "Intermediate".
- **Primary Activities:** Students use AI primarily to obtain answers to simple questions, search for and summarise articles, and create presentations.
- **Specific Accessibility Tools:** There is a stark lack of knowledge regarding specific accessibility tools. Only 5 students admit to using tools such as Be My Eyes and paracasainclusivo.com.br. Most participants (40 students) selected "Never" (Do not use). Nevertheless, 53.3% (24 students) admit that these tools can offer greater autonomy and decision-making power to a person with a disability, and 55.6% (25 students) believe that AI enables a person with a disability to recall or deepen prior knowledge, thereby facilitating the acquisition of more advanced knowledge.
- **Assistive Technology Gaps:** Nine students use traditional assistive technologies (e.g., noise-cancelling headphones, screen readers) without AI integration.

Taken together, these findings depict a landscape in which awareness of AI is widespread, yet its application to accessibility and inclusion remains marginal. Students predominantly use AI for generic productivity tasks, while specialised tools designed to support people with disabilities remain largely unknown or unused. This gap between general AI awareness and accessibility-specific practice, alongside the persistent reliance on traditional assistive technologies without AI integration, frames the discussion that follows.

5. Discussion

The results indicate that while there is an initial openness to AI tools, their potential to promote accessibility remains largely untapped at UFSM. The high frequency of "Never" responses for specialized academic and accessibility tools suggests that students are currently using AI for general productivity rather than as a tailored assistive resource.

In the context of this research, the most used chatbot and research assistant is Gemini, followed by ChatGPT and CoPilot. This may be because UFSM students are eligible for a 12-month free trial. For literature searches and reviews, the most used tool is Perplexity, but it is rarely used, even though students and researchers at UFSM can get 1 year of free access to the advanced AI research tool Perplexity Pro. In the context of visual content and presentations, as well as accessibility and inclusive adaptation, the most used tools (even rarely) were Canva or Gamma AI and paracasainclusivo.com.br, respectively. This can be explained by a workshop on these three tools that took place the previous month, and some of the participants were probably there.
Despite current low usage, 78% of respondents in the initial abstract findings (and corroborated by survey comments) agree that AI can offer greater autonomy and decision-making power to people with disabilities. However, a significant portion of the participants (e.g., those with ASD) expressed concerns that AI might "worsen a system that is already extremely flawed" if those developing the AI do not have disabilities themselves, potentially amplifying programmer biases.
Ethical concerns are a major theme. Students reported fears regarding the use of content "without real foundation" (hallucinations) and the "outsourcing of critical thinking". These findings align with the "Slow AI" concept, suggesting a need for a more considered, critical adoption of these technologies in the academic environment.
Finally, institutional role cannot be ignored. This study highlights a critical need for institutional support and digital literacy programs. The lack of prior reflection on the impact of AI on accessibility – as evidenced by frequent "I have not yet reflected on this" responses – suggests that the university must move beyond providing tools to fostering a culture of critical and creative AI use. The UFSM, like many other universities worldwide, has intensified its training initiatives in Artificial Intelligence (AI), ranging from the qualification of trainers to the creation of seminars and training courses for students.
The single-institution design limits the generalisability of these findings, but the transferable methodology – combining a mixed-methods survey with alignment to UDL and inclusive education frameworks – offers a valuable practical reference for educators and researchers seeking to replicate this approach in other institutional contexts.

6. Conclusions

This research demonstrates that, while AI offers promising tools for personalised teaching and content adaptation, its implementation for students with disabilities at UFSM remains incipient. The gap between AI's theoretical potential to promote accessibility and its current practical application is significant.
Although the findings are grounded in the specific institutional context of UFSM, the underlying methodology and the issues identified – limited awareness of accessibility-oriented AI tools, persistent reliance on non-AI assistive technologies, and a lack of critical reflection on AI's ethical implications – are unlikely to be unique to this setting. As such, the approach adopted here offers a transferable framework that other higher education and vocational institutions, particularly those engaged in similar inclusion efforts, may adapt to assess and address comparable gaps in their own contexts.
Key recommendations based on the findings include:

- **Targeted Training:** Implementing training programs for students and teachers focused on specialised AI accessibility tools.
- **Ethical Framework Adoption:** Using the Framework for the Responsible Development and Use of Artificial Intelligence in Education to guide institutional policies and mitigate risks of bias and "metacognitive laziness".
- **Inclusive Development:** Ensuring that the development and deployment of AI training courses or even AI tools involve the active participation of people with disabilities to avoid the amplification of existing prejudices.

Ultimately, the goal is to transform the pedagogical landscape from one of consumption to one of critical production, ensuring that AI serves as a bridge rather than a barrier to equity and social justice in Vocational and Technological Education.
In this line, the work in progress is planning and developing a training seminar on AI tools for students with disabilities and a training unit on Artificial Intelligence for professionals from the University's Accessibility centres (also open to professors).
This study has limitations that should be acknowledged. The sample size (n=45), drawn through convenience sampling from a single institution, restricts the generalisability of the findings, and the timing of data collection, near the end of the academic term, may have affected response rates and depth of engagement. Future research should pursue larger and more diverse samples, incorporate a qualitative phase to deepen understanding of students' lived experiences, and explore comparative

studies across institutions and countries, such as between UFSM (Brazil) and IPB (Portugal), to assess the broader applicability of AI-driven accessibility initiatives in Vocational, Technological, and Higher Education.

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An Online and Onsite Training for University Teachers' Professional Development: Methods and Data from the TED-SOEP Project

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Abstract

STEM teaching in higher education is increasingly challenged by uneven student engagement, persistent learning gaps and the difficulty of supporting lecturers in the adoption of student-centred pedagogies. Within this scenario, the Erasmus+ project "Transforming STEM Teacher Education in South Africa through Self-Directed Open Educational Practices" (TED-SOEP) was designed to strengthen the teaching competences of South African university lecturers and professors by promoting the integration of Open Educational Resources (OER) and Open Educational Practices (OEP) within a self-directed learning perspective. This contribution presents the design features and the evaluation outcomes of the professional development pathway implemented by the University of Florence as part of the project. The pathway is structured as an integrated blended training, combining an online environment that supports flexible, self-paced exploration of innovative pedagogical strategies, and a five-day onsite experience that consolidates theoretical principles and contextualises them through collaborative design activities. The 4Ts game, a serious game developed at CNR-ITD, was adopted during the onsite phase to scaffold lecturers' co-design of new teaching scenarios. The training is articulated in five thematic modules dedicated, respectively, to OER and OEP, Inquiry-Based Learning, Problem-Based Learning, Simulations of real-world scenarios and Game-Based Learning. Quantitative and qualitative data collected from 325 online participants and 25 onsite participants from five South African universities show that the integrated design supported differentiated learning trajectories, fostered the appropriation of innovative tools and methods, and enabled high levels of engagement and participants' intention to transfer the practices into their teaching contexts. Beyond presenting evidence on training effectiveness, the paper argues that the integration of self-directed online learning, in-presence consolidation and gamified collaborative design constitutes a methodologically grounded model of professional development for STEM educators.

Keywords: *Open Educational Resources, Open Educational Practices, STEM, Higher Education, Self-Directed Learning, Blended Teacher Training, 4Ts Game.*

1. Introduction

Science, Technology, Engineering and Mathematics (STEM) higher education is currently navigating a phase of profound transformation. Universities worldwide are confronted with the simultaneous demand to widen access, sustain the quality of instruction, and align curricula with rapidly evolving disciplinary and societal needs [1]. In this scenario, lecturers are expected not only to transmit specialised knowledge, but also to design learning experiences that are inclusive, student-centred and capable of mobilising digital tools, real-world data and active learning strategies. Yet, several investigations indicate that the pace of pedagogical innovation among university teaching staff is slower than the rate of change required by these expectations, and that traditional, transmissive teaching still represents a default option in many STEM departments [2].

These tensions are particularly acute in South Africa, where higher education institutions face the dual challenge of redressing structural inequalities inherited from the past and renovating their pedagogical approaches in STEM disciplines. Persistent gaps in student engagement, in scientific literacy, and in the preparation of future teachers represent obstacles for the development of an inclusive scientific workforce. Recent literature has stressed the importance of investing in academic professional development as a lever for systemic change in STEM education and has highlighted the role of Open Educational Resources (OER) and Open Educational Practices (OEP) in promoting more accessible, flexible and collaborative teaching [2].

The Erasmus+ project "Transforming STEM Teacher Education in South Africa through Self-Directed Open Educational Practices" (TED-SOEP, ERASMUS-EDU-2024-CBHE-STRAND-1) responds

precisely to these challenges. The project gathers two European universities (University of Florence and Polytechnic Institute of Bragança) and five South African universities (North-West University, University of the Witwatersrand, University of Pretoria, Sol Plaatje University, and University of South Africa). Its overarching goal is to enhance the teaching competences of South African STEM lecturers, professors and pre- and in-service teachers through training experiences and tools centred on the integration of self-directed OEP and OER.

Within this consortium, the University of Florence designed and implemented a comprehensive professional development pathway, structured as a blended programme consisting of an online course and a five-day onsite training experience. The pathway is intentionally articulated to combine flexibility and depth: the online phase offers each participant the opportunity to engage with a structured corpus of resources at their own pace, while the onsite phase, hosted in Florence in May 2025, consolidates the theoretical groundwork through immersive workshops, expert-led sessions and collaborative design activities. A central feature of the onsite week is the use of the 4Ts game, a serious game developed by the Italian Institute for Educational Technology of the Italian National Research Council (CNR-ITD), conceived to support teachers in the conceptualisation of collaborative learning activities [3]. While the design and outcomes of the online course and of the onsite training have been documented separately in earlier contributions [4], [5], the present paper adopts a more integrative perspective. Its aim is to present the full training package as a unitary intervention, to discuss its rationale in light of the literature on self-directed learning, OER/OEP and teacher professional development, and to bring together quantitative and qualitative evidence emerging from the two phases. By doing so, the paper contributes to the discussion on how blended models can effectively support pedagogical change in STEM higher education, especially when knowledge transfer between different geographical and institutional contexts is at stake.

2. Theoretical Background

2.1 Self-Directed Learning and Open Education in STEM

Self-Directed Learning (SDL) has long been considered a foundational concept in adult education. According to Loeng [6], SDL designates a process in which learners progressively take ownership of their learning by identifying their own needs and goals, selecting strategies and resources to address them, and finally evaluating the outcomes of their efforts. In this perspective, the learner becomes the protagonist of the educational process, while the teacher plays a facilitative role, scaffolding autonomy rather than dispensing prescriptive content. Far from being limited to learners, this paradigm is also relevant for university lecturers themselves, who are increasingly expected to act as autonomous, reflective designers of their own teaching practice.

OER have emerged in recent decades as a powerful infrastructure to support such SDL processes. Defined as freely accessible learning materials that can be reused, adapted and shared, OER include textbooks, multimedia content, datasets, simulations and assessment instruments. Hilton [7], in a synthesis of empirical studies, reported that OER are associated with student outcomes that are equal to, or in some cases better than, those obtained with traditional commercial materials, while at the same time reducing economic barriers to access. The complementary notion of OEP broadens this perspective: it shifts the focus from artifacts to the pedagogical practices through which open resources are designed, integrated and re-elaborated within authentic teaching contexts.

In STEM higher education, OER and OEP are particularly promising. They allow lecturers to integrate up-to-date scientific content, interactive simulations, and inquiry-oriented activities, while preserving the flexibility needed to adapt materials to local contexts. Kleinschmit and colleagues [2] have documented how the development and dissemination of OER through linked communities of practice can act as a sustainable engine for STEM teaching reform, fostering both faculty professional growth and student engagement. At the same time, the long-term sustainability of OER initiatives remains a research topic in its own right: as Tlili et al. [8] point out, the integration of OER into the everyday fabric of teaching, research and community engagement is what ultimately makes openness viable beyond pilot projects.

2.2 Blended Models for Teacher Professional Development

A growing body of evidence suggests that blended models, combining online and in-presence components, are particularly effective for teacher professional development [9]. Synthesising qualitative research on the topic, scholars have identified key components of effective blended programmes, including the alignment between online and onsite activities, the explicit support for collaboration among

participants, the modelling of innovative teaching strategies and the provision of opportunities for transfer to participants' own classrooms [10].
Within blended programmes, the online component is particularly suited to address the diversity of the audience: participants typically vary in disciplinary background, prior experience with educational technologies and degree of familiarity with student-centred approaches. A modular, asynchronous environment can accommodate this heterogeneity by allowing each user to progress according to their starting point and goals. The onsite phase, in turn, offers an irreplaceable opportunity for situated learning, social interaction, and joint design with peers and experts, thereby compensating for the more individualistic nature of online study.

2.3 Collaborative Design and the 4Ts Game

A specific challenge in teacher professional development is to translate theoretical knowledge into concrete pedagogical decisions. To address this gap, several research groups have proposed structured tools and serious games that scaffold learning design processes. Among these, the 4Ts model and the related 4Ts game, developed at CNR-ITD, have been widely studied as instruments to support teachers in the conceptualisation of collaborative learning activities [3], [12]. The model identifies four interrelated dimensions: the Task that learners will undertake; the Time over which the activity unfolds; the Team configurations that organise students' work; and the Technology that mediates and supports the interaction. By making these dimensions explicit and inviting designers to negotiate them with their peers, the 4Ts framework operationalises learning design as a deliberate, evidence-informed activity.

3. Methodology

This section describes the design and the implementation of the training package. It first illustrates the underlying instructional architecture, before detailing the online and the onsite components, the role of the 4Ts game, the participants involved, and the evaluation procedures adopted in each phase.

3.1 Architecture of the Training Package

The TED-SOEP training package designed by the University of Florence is organised around five thematic modules, each focused on a teaching strategy considered particularly relevant for STEM higher education: (1) OER and OEP, (2) Inquiry-Based Learning (IBL), (3) Problem-Based Learning (PBL), (4) Simulation of real-world scenarios, and (5) Game-Based Learning (GBL). The same five modules are addressed both in the online course and in the onsite training, but with complementary emphases and methodologies. The online phase prioritises individual exploration, theoretical grounding and gradual application; the onsite phase prioritises consolidation, contextualisation in participants' disciplines and collaborative design.
This articulation reflects an intentional pedagogical choice. Rather than juxtaposing two separate experiences, the package is conceived as a continuum: the online environment activates prior knowledge and introduces the conceptual building blocks of each strategy, while the onsite week deepens these foundations through expert-led sessions, demonstrations from STEM disciplines, and structured design tasks. Together, the two phases enact the cycle of activation, demonstration, application, and integration that lies at the heart of Merrill's principles [11].

3.2 The Online Course

The online course is hosted on the project platform (https://www.tedsoep.org/TR_online.php) and is freely accessible to South African STEM lecturers, professors and pre- and in-service teachers. Each of the five modules follows a common four-phase structure inspired by Merrill's First Principles of Instruction: an Activation phase, which introduces the topic and stimulates motivation; a Documentation phase, which presents two video lessons supplemented by automatic subtitles, and written transcripts in order to accommodate different learning preferences; an Application phase, which suggests interactive platforms and digital tools that can be used by lecturers and their students to design or carry out activities; and an Integration phase, which synthesizes the key contents and offers self-evaluation checklists. Each module is composed of a five-item multiple-choice test, administered before and after the learning activities, allowing participants to monitor their own progress and provides the research team with quantitative indicators of skills acquisition.

The five tests are aligned with the specific learning objectives of each module. For instance, in Module 1 participants are asked to recognise the criteria that allow the quality of OER to be evaluated; in Module 2 they reflect on the goals of the conceptualisation phase of inquiry-based activities; in Module 3 they identify the role of the teacher within problem-based scenarios; in Module 4 they discuss the skills that simulations can foster in STEM; in Module 5 they consider the alignment between game-based learning and the goals of higher education. Through the entire course, the design embraces a self-directed perspective: learners can navigate modules in different orders, revisit content asynchronously, and integrate the suggested applications into their own professional reality.

3.3 The Onsite Training

The onsite training, titled “Innovative STEM Teaching in Higher Education: from Theory to Action”, was held in Florence from 26 to 30 May 2025. It was organised over five working days, with each day dedicated to one of the five thematic modules, and articulated into a morning and an afternoon session. The mornings hosted expert-led lectures, demonstrations and example analysis delivered by professors, researchers and research fellows of the University of Florence active in different STEM areas. The presentations illustrated concrete applications of each strategy in real disciplinary contexts: for example, the integration of artificial intelligence in the design of OER; the use of LEGO-based hands-on tasks to support inquiry-based learning in engineering; the simulation of complex systems through NetLogo for game-based learning; the deployment of 360-degree video in agricultural studies; and the implementation of problem-based scenarios with the support of digital technologies.
The afternoons were dedicated to collaborative workshops in which participants, organised in small groups, were invited to design new STEM teaching activities through the 4Ts game framework [3]. Each group worked iteratively on the four dimensions of Task, Time, Team, and Technology, transforming the theoretical inputs of the morning into concrete teaching scenarios that could be deployed in their home institutions. The game served as both a scaffold for design decisions and as a shared language across participants of different STEM disciplines, supporting the negotiation of pedagogical choices and the exchange of expertise.

3.4 Participants

A total of 325 South African professors, lecturers, pre-service and in-service STEM teachers completed the online course. According to their pre-test scores in each module, they were grouped into three profiles to allow a more nuanced analysis of the impact of the training: Low-skills users (0–2 correct answers, with limited or no prior knowledge), Medium-skills users (3–4 correct answers, with moderate prior knowledge or experience), and High-skills users (5 correct answers, with consolidated prior knowledge). This profiling acknowledges the heterogeneity of the audience and supports the interpretation of pre/post variations in light of different starting points.
The onsite training in Florence involved 25 university lecturers from the five South African partner universities, with five participants per institution. Their academic profiles ranged from Lecturers (14) and Senior Lecturers (7) to Associate Professors (3) and Full Professors (1); two of them held additional roles as Directors or Deputy Directors of their Department. The disciplinary backgrounds were equally distributed across Mathematics education (28%), Science education – including natural science, life science and chemistry education (28%), Technology education (28%), with the remaining 16% spread across Computer education, Physics, early science and Mathematics education, and teacher education. This composition deliberately mirrors the variety of fields that compose STEM in higher education and feeds the project's ambition to disseminate good practices broadly.

3.5 Evaluation Procedures

The two phases of the training were monitored through complementary evaluation strategies. The online course used pre/post multiple-choice tests at module level: each test consisted of five closed-ended items aligned with the module's learning objectives. The variation between pre- and post-test scores was interpreted differently depending on the user profile: as a learning gain for Low- and Medium-skills users, and as a consolidation of prior knowledge for High-skills users.
At the end of the onsite training, participants completed a satisfaction questionnaire articulated in five dimensions, each rated on a 1–10 scale: (i) relevance of the training contents, (ii) effectiveness of the teaching methodology, (iii) accessibility of the didactical resources, (iv) clarity of the training contents, and (v) competence of the trainers. The questionnaire also included open-ended fields, where

participants could elaborate on what they considered most valuable, what could be improved and how they intended to use the experience in their own work.

4. Results

4.1 Outcomes of the Online Course

The analysis of pre- and post-test scores in the online course highlights a positive impact on participants' competences, with patterns that vary across the three user profiles. Low-skills users show consistent improvements across all five modules: their average pre-test scores, ranging from 1.3 to 1.7 correct answers, rise to post-test averages between 3.5 and 4.3. The largest gain is observed in Module 1, dedicated to OER, where the mean increases from 1.5 to 4.0, and in Module 5, on Game-Based Learning, where the mean rises from 1.6 to 4.3. Medium-skills users show more contained but still discernible improvements, generally moving from average scores around 3.5–3.7 to post-test means between 4.0 and 4.4; the only exception is Module 4 on simulations, where the variation is marginal (from 3.6 to 3.7). High-skills users, who already obtained the maximum score in the pre-test, tend to confirm their performance in the post-test, signalling a consolidation rather than a learning gain.
These trends are reinforced when the focus shifts from group to the proportion of users who improved (or maintained the maximum) between pre- and post-test, as summarised in Table 1. The percentage of Low-skills users who increased their correct answers exceeded 80% in four modules out of five, peaking at 93% in the OER module. Among Medium-skills users, the proportion of participants who improved their scores ranges from 51% (Module 4, Simulations) to 72% (Module 3, PBL). High-skills users maintain the maximum score in 79% to 86% of cases, depending on the module. Taken together, these results indicate that the online course supported differentiated learning trajectories: bridging gaps for less experienced users, refining knowledge for intermediate ones, and consolidating expertise for advanced participants.

Table 1. Percentage of online course participants who improved or consolidated their performance, by user profile and module.

Profile / Indicator	Mod 1 OER	Mod 2 IBL	Mod 3 PBL	Mod 4 SIM	Mod 5 GBL
Low-skills users (% improving)	93%	84%	75%	85%	92%
Medium-skills users (% improving)	64%	64%	72%	51%	62%
High-skills users (% maintaining max score)	84%	83%	84%	86%	79%

The marked variation between Module 4 (Simulations) and the other modules among Medium-skills users deserves particular attention. The smaller gain may be related to the intrinsic complexity of simulation-based teaching, which requires the integration of disciplinary content, technological tools and reflection on cognitive processes. It also resonates with feedback collected during the onsite phase, which suggested that the simulation module would benefit from additional space for case-based discussion and from more practical examples drawn from participants' own disciplines.

4.2 Outcomes of the Onsite Training

Engagement during the five-day onsite training was high. Participants attended morning and afternoon sessions consistently and contributed actively to discussions and design tasks. The satisfaction questionnaire confirmed a very positive perception of the experience. The dimension that received the highest score was “competence of the trainers”, with an average of 9.2/10, signaling appreciation for the involvement of professors and researchers from different STEM areas. Relevance and clarity of contents were rated 8.6 and 8.5 respectively, while effectiveness of the teaching methodology and accessibility of the resources received 8.2 and 8.1. The overall mean score across the five dimensions was 8.5/10. Table 2 summarizes these results.

Table 2. Average scores attributed by onsite participants to each dimension of evaluation.

Dimension of evaluation	Mean score (1–10)
Relevance of the training contents	8.6
Effectiveness of the teaching methodology	8.2
Accessibility of the didactical resources	8.1
Clarity of the training contents	8.5
Competence of the trainers	9.2
Overall average	**8.5**

Beyond the quantitative ratings, the qualitative answers provided by participants offer a richer picture of the perceived value of the experience. Three thematic clusters emerged consistently. The first cluster concerns the discovery of new digital tools, with particular emphasis on artificial intelligence applications, simulation environments and AI-supported creation of OER. Approximately eleven respondents out of twenty-five made explicit reference to this dimension, mentioning the intention to integrate the new tools into their teaching practice as soon as they returned home. The second cluster concerns the appropriation of innovative teaching strategies. Several participants stressed the value of being exposed to different active-learning approaches and indicated that they would translate them into modules for pre-service teacher education at their universities. The third cluster concerns the perceived expertise of the trainers and the multidisciplinary nature of the offer, which several respondents associated with the variety of perspectives proposed across the five days.

An additional aspect worth highlighting is the dual orientation towards teaching and research, that participants attributed to the experience. A subset of respondents reported that the training was inspirational not only for their classroom practice, but also for their research agenda, suggesting potential collaborations with European partners and stimulating new lines of inquiry. The collaborative climate of the workshops, supported by the 4Ts game and by the constant interaction between trainers and trainees, was likewise mentioned as a factor that strengthened the learning experience and that fostered a sense of community among participants from different institutions.

Critical observations were limited but informative. A few respondents noted that the overall duration of the training was demanding, given the density of contents addressed every day. Others suggested that more space could be allocated for participants to share their own experiences and to discuss how each strategy could be adapted to their local contexts. Some participants asked for additional practical examples in specific modules, in line with the more limited gains observed in the simulation module of the online course.

5. Discussion

The integrated reading of the online and onsite phases offers several insights for the design of professional development programmes for STEM higher education. A first point concerns the complementarity of the two components. The online course supported a flexible, self-paced exploration of the five strategies and demonstrated the ability to address users with very different starting points, providing measurable gains. The onsite training, in turn, situated these contents within concrete disciplinary practices, gave space to peer interaction and modelled how innovative strategies are negotiated, refined and adapted to specific teaching contexts.

A second point concerns the role of the 4Ts game. The game enabled participants to translate the morning lectures into structured design exercises, providing shared vocabulary across very different disciplinary backgrounds and supporting the kind of conceptualisation work that is at the core of effective learning design [3], [12]. From a methodological standpoint, the systematic use of the 4Ts framework across the five thematic days produced a recognisable pattern of activity – input, design, refinement, sharing – that contributed to the perceived coherence of the week. The high score attributed to the competence of trainers and to the clarity of contents is consistent with this interpretation: the game offered a robust scaffold within which trainers' expertise could be effectively channelled into design-oriented tasks.

A third point concerns the alignment of the package with the principles of self-directed learning. By offering modular online materials, embedded self-evaluation, and the possibility for participants to revisit content according to their needs, the online course is consistent with the SDL perspective described by

Loeng [6]. The onsite phase complements this by promoting self-directed micro-decisions within the design tasks: participants negotiate task complexity, technology choices and team configurations as a function of the contexts they will eventually return to. In this sense, the package not only teaches innovative pedagogical strategies, but also models a self-directed approach to professional development, in line with Kleinschmit and colleagues' [2] argument about communities of practice as drivers of sustainable change in STEM education.

A fourth point relates to the broader transferability of the model. TED-SOEP is built around the explicit ambition of facilitating the circulation of expertise between European and South African universities. The trained lecturers and professors, in turn, were expected to act as multipliers within their own institutions through national workshops, reaching additional colleagues, and progressively diffusing the practices acquired in Florence. The intention to apply the methods, repeatedly expressed in the qualitative answers, suggests that this multiplier function is plausible. At the same time, the suggestions for additional spaces of experience-sharing and for further practical examples reinforce the importance of explicitly designing for adaptation: when programmes are intended to circulate across very different cultural and institutional contexts, opportunities for participants to recontextualise contents are not optional features, but constitutive components of the design.

Some limitations need to be acknowledged. The evaluation strategies adopted in the two phases are different in nature: the online course relied on multiple-choice tests aligned with module learning objectives, while the onsite training was assessed through a satisfaction questionnaire and qualitative comments. While the two perspectives are complementary, they do not allow a direct comparison of skills acquisition between phases. In addition, the empirical evidence collected so far focuses on participants' immediate reactions and on short-term changes in declarative knowledge; medium- and long-term effects, including the actual implementation of the strategies in participants' classrooms, will need to be investigated in subsequent project activities. Finally, the analysis of qualitative data was based on a relatively small number of respondents and identified recurring themes rather than statistically robust patterns; further data collection during the national workshops will help to refine these findings.

It is also worth noting that the integration of the 4Ts game with the five thematic modules helped to mitigate a recurrent risk in teacher education programmes, namely the gap between exposure to innovative content and its actual translation into classroom practice. By systematically requiring participants to design new activities at the end of each daily session, the workshops produced concrete artifacts that could be discussed, refined and shared among groups. This rhythm – input, design, refinement, sharing – contributed to a culture of evidence-informed pedagogical decision-making which is consistent with the broader objectives of the TED-SOEP project and with the literature on linked communities of practice in STEM education [2].

6. Conclusions

This paper presented the integrated training package designed by the University of Florence within the TED-SOEP project, with the goal of strengthening STEM teaching competences among South African higher education lecturers and professors. The package combines an online course, organised in five modules and grounded in Merrill's First Principles of Instruction, with a five-day onsite training in Florence that consolidates contents through expert-led sessions and gamified design workshops based on the 4Ts framework. The two phases share the same conceptual scaffolding – the five themes of OER and OEP, Inquiry-Based Learning, Problem-Based Learning, Simulations and Game-Based Learning – but mobilise different methodological resources to address them.

Quantitative and qualitative evidence indicates that the package supported differentiated learning pathways. The online course produced measurable gains for less experienced users, more contained but visible improvements for intermediate users and consolidation effects for advanced participants. The onsite training was rated very positively across all dimensions of evaluation, with particular appreciation for the competence of the trainers, the relevance and clarity of the contents, and the opportunity to engage with innovative tools and methods within a collaborative environment. Participants explicitly indicated their intention to transfer the acquired strategies to their own classrooms and, in some cases, to their research practice.

Beyond its specific outcomes, the experience suggests that integrated blended designs that combine online SDL, in-presence consolidation and gamified collaborative design can constitute a viable model of professional development for STEM educators. Future iterations of the package will benefit from the suggestions emerged during the evaluation: more space for sharing participants' experiences, additional practical examples in selected modules, and refined strategies for follow-up beyond the training week.

As the project moves forward, the lessons learnt within TED-SOEP can inform similar initiatives where pedagogical innovation needs to travel between higher education institutions, disciplines and geographical contexts, while preserving the autonomy and the contextual sensitivity of the lecturers it aims to support.

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Prompting Disciplinary Literacy: A Case Study of Gen AI as a Scaffold for Specialized Text Production in Environmental Studies

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Abstract

This study explores the integration of Generative Artificial Intelligence (GenAI) as a pedagogical tool to support undergraduates in the bachelor's degree in Human Sciences of Environment, Landscape, and Territory in understanding and producing specialized disciplinary texts in English. Since the course syllabus combines geography, anthropology, environmental studies, and spatial planning, students often encounter difficulties with the linguistic and rhetorical conventions required for academic and professional communication. To address these challenges, a semester-long intervention based on prompt engineering and iterative co-writing with GenAI tools (e.g., ChatGPT-4 and CoPilot 365) was implemented with 42 second-year students. Through scaffolded workshops, students learned to create discipline-informed prompts, analyse model texts, identify specialized lexicon and syntactic patterns, and critically revise AI-generated outputs. Qualitative and quantitative analyses of writing samples, students' reflections and assessed final tasks, demonstrated notable improvements in terminology precision, argumentative organisation, genre awareness, and confidence in using academic English within disciplinary contexts. Enhanced metalinguistic awareness reflected students' ability to apply appropriate rhetorical and lexical-grammatical strategies to disciplinary communication. The preliminary findings suggest that GenAI can function as a collaborative mediator in disciplinary writing development, providing a replicable framework for integrating AI into EMI (English as a Medium of Instruction) contexts through prompt literacy and critical revision practices.

Keywords: *Generative Artificial Intelligence (GenAI); EMI (English as a Medium of Instruction); Specialized literacy; Prompt engineering*

1. Introduction

Generative AI tools can support undergraduates who struggle with academic discourse and specialized terminology by making language patterns more visible and manageable. Rather than automating learning, these tools scaffold it, helping students focus on structure, register, and rhetorical conventions that are often difficult to grasp through analysis alone. As Hyland argues, "academic writing is as much about rhetorical control as linguistic accuracy" (Hyland, 2004, p.134), while Flowerdew observes that "learners benefit from guided exposure to disciplinary discourse" (Flowerdew, 2015, p.15). Thus, GenAI acts as a cognitive and linguistic aid, enabling students to engage more confidently with academic language without replacing the learning process itself.

2. Background

The present study was conducted with a group of 42 second-year undergraduates enrolled in a Bachelor's degree in Human Sciences at the Faculty of Human Sciences of Environment, Landscape and Territory, University of Milan, Italy. The participants were attending an English for Academic Purposes (EAP) mandatory course (40 hours; 4 CFU) and an English for Specific Purposes (ESP) elective workshop (20 hours; 2 CFU) during the first and second semesters of the 2024/2025 academic year. All participants had an assessed language proficiency at B2 level (CEFR), which provided a sufficiently advanced baseline for engagement with complex academic and disciplinary texts and with AI-mediated language tasks. Both the EAP and ESP components were conceived as semester-long programmes aimed at fostering students' production and comprehension of academic and discipline-specific texts within the broader field of environmental sciences. The EAP course focused primarily on academic literacy practices such as reading research articles, synthesising sources, and producing structured written assignments, while the ESP workshop concentrated on the linguistic and genre features of professional and disciplinary communication relevant to environment, landscape, and territory studies. These parallel strands created a rich context for observing how students struggle with

both general academic conventions and the more specific discourse practices related to the environmental disciplines, and also how, conversely, they manage to negotiate academic and disciplinary discourse when supported by both traditional and AI-mediated scaffolding.

3. Learning Challenges and Research Questions

3.1 Environmental Studies' Interdisciplinary Demands

The Bachelor's degree in Human Sciences of Environment, Landscape, and Territory positions undergraduates at a complex intellectual crossroads, integrating the contents of geography, anthropology, environmental studies, and spatial planning within a single degree course. This convergence forces students to simultaneously navigate each disciplinary constituent. Spatial planning alone, for instance, interfaces with institutionalist theory, critical discourse analysis, and policy-oriented argumentation to examine how environmental narratives are embedded in territorial governance. Preparing students to operate within this multidisciplinary field, therefore, requires more than subject-matter competence; it demands an awareness of how knowledge is constructed and communicated across disciplinary boundaries.

3.2 EAP-ESP Communication Complexity

The interdisciplinary nature of the degree program creates a complex set of communication requirements in academic English and English for Specific Purposes (EAP/ESP). Students are expected to produce texts that simultaneously integrate technical vocabulary derived from environmental and land-use sciences with interpretive writing in line with the rhetorical conventions of urban and regional planning documentation. As research on ESP writing consistently demonstrates, the difficulty lies not only in linguistic accuracy but in mastering the discipline-specific conventions, styles, and genre structures that constitute credible academic discourse within each field (Hyland, 2022, p. 202). Genre-based studies confirm that even advanced L2 writers struggle with the organisational and stylistic dimensions of disciplinary writing when these features are not made explicit through targeted instruction. The resulting communicative burden is particularly heavy in programs that span multiple disciplines, where no single genre framework can serve as a stable reference point.

3.3 Linguistic Barriers

Students enrolled in the Environmental degree program face a dual acquisition challenge: they must build domain-specific content knowledge while simultaneously developing the specialised English register through which that knowledge must be communicated. This accounts for three interrelated areas of linguistic difficulty: terminological precision in environmental discourse, rhetorical conventions governing territorial analysis and genre awareness in policy-oriented writing. These barriers point to a fundamental gap between conceptual understanding and discursive competence that standard content-area instruction rarely addresses and, EFL students frequently grasp.

3.4 Learning Objectives and Research Questions

The three convergent pressures described above -interdisciplinary cognitive demand, multi-genre communicative expectations, and layered linguistic barriers- together generated a critical pedagogical problem. Students in Human Sciences programs may demonstrate conceptual grasp of environmental, territorial, and anthropological content, yet lack the discourse resources to materialize that understanding in academic specialised English. This gap between content knowledge and discursive performance constitutes the epistemic core of the present study.

A growing body of research suggests that Generative Artificial Intelligence (GenAI) tools, when integrated into structured pedagogical contexts rather than used simply as writing aids, can serve as interactive mediators for the development of disciplinary writing (Barrot, 2023, p. 2). Furthermore, improved writing outcomes have been documented when students engage in recursive and iterative interaction with AI tools, rather than using them simply as editorial assistants, with the most significant effects emerging when AI support is combined with self-paced learning strategies. Research specifically in EAP (English for Academic Purposes) contexts (Barrot, p. 4) also demonstrates that prompt-guided GenAI use fosters awareness of text genre and academic register. This positions GenAI as a pedagogical mediator capable of supporting the transition from implicit content knowledge to explicit

discursive performance, a function of fundamental importance in the context of the degree program under consideration.
Against this backdrop, the present study is framed by four research questions that target the most critical and underexplored dimensions of disciplinary ESP/EAP writing for students in Human Sciences of Environment, Landscape, and Territory:
RQ1 — *Terminology*: How accurately can students deploy environment-specific terminology in ESP/EAP written discourse?;RQ2 — *Rhetorical Conventions:* To what extent can students master the rhetorical conventions of territorial analysis in academic English?; RQ3 — *Argumentation & Genre*: How effectively can students construct genre-appropriate argumentative structures in urban policy writing?; RQ4 — *GenAI as Mediator:* Can GenAI function as a pedagogical mediator for specialised disciplinary writing?
Therefore, the learning goals of this study addressed the four dimensions of L2 academic writing:
1) to implement the academic vocabulary gap in advanced EFL learners within environmental science;
2) to face the rhetorical hurdles caused by cross-linguistic and disciplinary differences in argumentation;
3) to foster the students' ability to produce genre-appropriate, policy-oriented urban planning texts; and
4) to introduce the potential of GenAI to mediate and bridge the gap between conceptual understanding and academic discursive competence.

4. Pedagogical and Theoretical Framework

4.1 CALP and the Academic Language Horizon

The communication difficulties described in the previous sections cannot be adequately addressed with interventions that treat the language difficulty as a superficial grammatical problem. Cummins's (1981) fundamental distinction between basic interpersonal communication skills (BICS) and cognitive academic language competence (CALP) provides an essential diagnostic framework for understanding the depth of the difficulty. While BICS -the conversational, contextualized register of everyday interaction - typically develops within two years of exposure to a new language, CALP operates at an entirely different cognitive level: it is abstract, context-free, and requires the simultaneous use of specialized vocabulary, complex reasoning, and discipline-specific modes of expression. It is crucial to emphasize that Cummins's model consistently demonstrates that the full development of CALP requires five to seven years of sustained academic exposure and that students may display apparent oral fluency while remaining significantly unprepared for the cognitive and discursive demands of academic writing. For students in the Bachelor's Degree in Human Sciences of the Environment, Landscape, and Territories, who must simultaneously navigate the CALP registers of geography, anthropology, environmental policy, and territorial planning, and do so in English as a second language, the developmental gap between communicative competence and mastery of academic discourse is therefore both structurally predictable and practically urgent.

4.2 Scaffolding and the Zone of Proximal Development

If CALP theory identifies the nature and depth of the linguistic challenge, Vygotsky's (Chaiklin, 2003) framework offers the primary pedagogical response through the interconnected concepts of the Zone of Proximal Development (ZPD) and scaffolding. The ZPD designates the productive space between what a learner can accomplish independently and what becomes achievable through structured interaction with a more knowledgeable interlocutor -a space in which, according to Vygotsky, the most meaningful learning occurs-. Scaffolding translates ZPD theory pedagogically: it refers to the temporary, calibrated support (such as pre-teaching specialised vocabulary, providing visual organisers, modelling analytical moves, and supplying sentence frames) that allows learners to engage successfully with tasks that lie beyond their current independent capacity. Critically, the scaffold is not permanent: as students become more proficient, the scaffold is gradually removed, ensuring that support fosters independence rather than dependence. In the present study context, scaffolded instruction targets the three most demanding registers of disciplinary English for students: terminological precision in environmental discourse, the rhetorical conventions of territorial analysis, and the genre-appropriate argumentative structures of urban policy writing, each requiring distinct lexical, syntactic, and organisational scaffolds to activate productive performance within the ZPD.

4.3 GenAI Prompt Engineering as Collaborative Scaffold

The emergence of Generative AI as a pedagogical resource represented a significant extension of the scaffolding theory into technologically mediated learning environments, enabling forms of iterative, responsive support that were previously difficult to achieve at scale in disciplinary writing instruction. In our framework, GenAI was not conceived as an autonomous writing aid or a replacement for discursive agency, but as a collaborative interlocutor supporting noticing, drafting, and revising: the three recursive processes through which writers develop awareness of genre conventions, lexical choices, and rhetorical organisation. Prompt engineering, the practice of designing structured, purposeful instructions that guide GenAI outputs toward disciplinary norms, thus functioned as a metacognitive scaffold in its own right: it required students to make explicit decisions about register, genre, audience, and argumentative stance before engaging with AI-generated responses, thereby activating the higher-order thinking that defines CALP. A semester-long intervention integrating prompt engineering and iterative co-writing with GenAI tools in a BA in Human Sciences of Environment, Landscape, and Territory programme produced measurable improvements in "terminology precision, argumentative organisation, genre awareness, and confidence in using academic English within disciplinary contexts," as well as enhanced metalinguistic awareness in students' deployment of rhetorical and lexical-grammatical strategies. These findings confirm that GenAI, when embedded within a principled scaffolding framework aligned with ZPD theory and CALP developmental targets, can function as a collaborative mediator in disciplinary writing development.

5. Methodology

The proposed methodology adopts a genre-based, GenAI-integrated pedagogical framework designed to systematically develop students' English for Specific Purposes (ESP) competence. This approach is structured across four interconnected phases—Learning, Scaffolding, Production, and Evaluation—culminating in targeted follow-up activities that prepare students for multimodal academic assessments.

5.1 Learning: Developing GenAI Prompt Literacy

The foundational phase focuses on cultivating students' GenAI prompt literacy, transforming them from passive consumers of AI output into active, strategic users of the technology. Students are explicitly taught how to craft precise prompts that require them to first identify and articulate core components of academic communication, including communicative purpose, target audience, genre conventions, and relevant disciplinary terminology. By engaging with GenAI agents in this analytical capacity, learners develop a metacognitive awareness of how disciplinary communication is structured. This phase ensures that students understand the underlying rhetorical patterns of their field before attempting to generate or manipulate text, thereby grounding their AI interactions in sound pedagogical principles rather than mere text generation.

5.2 Scaffolding: Deconstruction and Noticing through GenAI

Building on this foundational literacy, the scaffolding phase employs GenAI as a dynamic discourse analysis tool to facilitate the "noticing" of key linguistic and rhetorical features. Students are guided to deconstruct authentic, discipline-specific model texts with the assistance of GenAI prompts designed to highlight specific elements. Through this collaborative deconstruction, learners systematically identify and analyse rhetorical moves, specialized lexicon, discipline-specific collocations, and pragmatic hedging patterns. This structured noticing process makes the implicit conventions of academic writing explicit, providing students with a clear, analysable blueprint of the target discourse before they are expected to produce it themselves.

5.3 Production: Iterative GenAI Co-writing

The production phase shifts the focus from analysis to active creation through iterative, collaborative co-writing. Rather than relying on GenAI to produce finished drafts, students engage in continuous refinement cycles characterized by active human-machine interaction. Students draft sections of their ESP texts and then use GenAI to critique, suggest structural improvements, or propose lexical enhancements. This cyclical process of drafting, prompting, evaluating, and revising fosters a collaborative writing environment. It encourages students to maintain authorial agency while leveraging

AI to push the boundaries of their linguistic and rhetorical competence, ultimately leading to more sophisticated and polished academic texts.

5.4 Evaluation: Critical Review and Human-in-the-Loop

Integral to this methodology is the evaluation phase, which emphasizes critical digital literacy and the "human-in-the-loop" paradigm. Students are trained to critically review and audit AI-generated or AI-assisted outputs for stylistic accuracy, disciplinary reliability, and academic integrity. This involves cross-referencing AI suggestions with authentic corpus data or course materials to

6. Classroom Practices

These examples illustrate how GenAI can be employed in various stages of Specialized Language Learning (ESP), providing concrete support to students, particularly in the context of environmental and territorial studies.

6.1 Terminological Expansion and Context

Scenario: A student encounters a technical term in a specialized text and needs to understand its nuances and usage in different disciplinary contexts. Example of Interaction with GenAI:
Student Prompt: "Explain the term '*ecological resilience*' in an urban planning context, providing 3-4 related synonyms or concepts and an example sentence where it is used correctly in a technical report".
GenAI Output (synthesized): "*Ecological resilience in urban planning refers to the capacity of an urban ecosystem to absorb disturbances and reorganize while essentially retaining the same function, structure, identity, and feedback. It's not just about returning to the original state, but about adapting and persisting"*. Pedagogical Value: This example shows how GenAI can act as a dynamic and contextualized glossary, helping students build a richer specialized vocabulary and understand the pragmatic use of terms.

6.2 Re-phrasing and Register Adjustment

Scenario: A student has written a paragraph with overly informal or generic language and needs to elevate its register to make it suitable for an academic or professional audience. Example of Interaction with GenAI:
Student Prompt: "Rewrite the following paragraph in a more formal and academic tone, suitable for a scientific publication in the field of human geography. Avoid colloquialisms and use more precise language: 'People are moving from the countryside to cities too much, and this creates a lot of problems for the environment and how we live". GenAI Output (synthesized): "'*The current trend of demographic migration from rural areas to urban centres is generating complex socio-environmental impacts. Such accelerated urbanization raises critical issues related to ecological sustainability and the quality of life in metropolitan areas*". Pedagogical Value: AI helps students practice rephrasing, a key skill in ESP, allowing them to compare their own style with academic style and identify lexical and syntactic differences.

6.3 Comparative Analysis of Model Texts

Scenario: Students need to understand the rhetorical and structural conventions of different specialized text genres (e.g., technical report vs. research article). Example of Interaction with GenAI:
Student Prompt: "Compare the typical structure and linguistic characteristics of an 'Environmental Impact Assessment (EIA) Report' and a 'Research Article on Landscape Ecology'. Highlight the differences in terms of purpose, audience, use of verb tenses, and presence of specific sections (e.g., methodology, recommendations)". GenAI Output (synthesized): • "*EIA Report: Practical/ decision-making purpose, mixed audience (stakeholders, decision-makers), predominant use of present and future tenses for recommendations, key sections: project description, impact analysis, mitigation measures, conclusions, and recommendations. Prescriptive language"*. *Research Article: Informative/theoretical purpose, academic audience, predominant use of past tense for methodology and results, key sections: introduction, literature review, methodology, results, discussion, conclusion. Analytical and objective language".* Pedagogical Value: GenAI facilitates textual genre analysis, a

fundamental aspect of ESP, enabling students to internalize the expectations of different professional communicative contexts.

6.4 Hypothesis Generation and Terminological Brainstorming

Scenario: A student is starting a research project and needs ideas for possible hypotheses or a brainstorming of key terms for a specific topic. Example of Interaction with GenAI:
Student Prompt: "I am an environmental science student preparing a project on plastic waste management in coastal areas. Generate 5 possible research hypotheses and a list of 10-15 key terms I should consider for my research". GenAI Output (synthesized): *"Research Hypotheses:1.1 The implementation of circular economy programs significantly reduces the accumulation of microplastics on urban beaches. 1.2 Public awareness of marine plastic risks is directly correlated with the adoption of waste reduction behaviours among coastal residents. Key Terms: micro-plastics, macro-plastics, marine pollution, circular economy, coastal waste management, ecotoxicology, bioaccumulation, single-use plastic directive, citizen science, upcycling, biodegradation, anthropogenic impact, sensitive coastal zones".* Pedagogical Value: AI acts as a brainstorming partner, stimulating creativity and providing a structured starting point for research, including relevant terminology for the field.

7. Final Assignments and Rubric

Student practice is structured around targeted online activities (*e-tivities*) designed to build and test foundational academic and professional competencies. The first e-tivity requires students to analyze and describe charts, graphs, and diagrams, compelling them to utilize formal academic vocabulary and integrate reliable sources. This task is specifically designed to hone their data interpretation and academic writing skills. The second e-tivity involves the creation of a professional e-portfolio. In this activity, students must effectively present their academic achievements, developed skills, and personal interests, thereby fostering digital literacy and professional self-presentation in a modern academic context. Building upon these foundational skills, students are tasked with compiling a comprehensive academic research project on a topic of their choice. This project must strictly adhere to established academic conventions, encompassing essential components such as an abstract, methodology, literature review, data analysis, and findings. To complement the written document, students are also required to deliver a visual presentation of their research. This assignment must align with academic design conventions, paying careful attention to appropriate font choices, text size, cohesive colour schemes, and the strategic, professional use of images to enhance clarity and audience engagement.
The evaluation of these assignments is guided by a comprehensive rubric that emphasizes both academic rigor and the strategic, transparent integration of Generative AI. Assessors will evaluate the presence of identifiable research project moves and specialized discourse, alongside the effective application of academic and technical language. A key criterion is the effective use of GenAI prompting to scaffold specialized register and language, with the prompting process required to be openly visualized. Furthermore, students are assessed on their ability to communicate their results effectively and their conscious, ethical use of safe and free GenAI tools to successfully meet their linguistic and academic objectives.

8. Findings

The findings from this GenAI-integrated ESP initiative reveal substantial quantitative and qualitative gains in student performance, validating the effectiveness of the pedagogical approach. Most notably, there was a significant improvement in terminology precision, with students demonstrating a marked enhancement in their accurate and confident usage of domain-specific vocabulary. This lexical growth was directly facilitated by targeted GenAI prompting, which allowed learners to iteratively refine their word choices. Furthermore, students exhibited an enhanced argumentative structure, particularly in the organization of complex territorial analyses. The scaffolding provided by AI tools helped them logically sequence their methodology, data, and findings, resulting in more coherent, rigorous, and professionally structured academic arguments. Beyond structural and lexical improvements, the intervention fostered profound stylistic and cognitive developments. Students displayed heightened genre awareness, evidencing a clear and effective distinction between the formal conventions of academic research and the pragmatic, persuasive styles required for professional communication, such as in their e-portfolios. This was closely linked to significant metalinguistic growth; learners developed an increased ability to critically evaluate and explicitly justify their linguistic choices based on specific disciplinary standards.

Rather than passively accepting AI-generated text, students actively engaged in critical revision, consciously articulating why certain registers or terminologies were appropriate for their specific academic or professional audiences.
Ultimately, these results underscore the efficacy of positioning GenAI not merely as a text generator, but as a dynamic mediator in ESP learning. By transparently visualizing the prompting process and emphasizing the conscious, ethical use of safe tools, the curriculum successfully cultivated autonomous and critically aware learners. The combined quantitative and qualitative gains confirm that when GenAI is strategically integrated alongside clear rubrics and deliberate scaffolding, it significantly elevates students' mastery of specialized discourse, thoroughly preparing them for the rigorous demands of both academic research and professional practice.

9. Conclusions

Ultimately, the true power of Generative AI in English for Specific Purposes lies not in its ability to produce flawless text, but in its capacity to illuminate the hidden mechanics of specialized discourse. When educators thoughtfully weave together prompt literacy, rigorous discourse analysis, and reflective revision, the Large Language Model transcends its role as a mere text generator. Instead, it emerges as a dynamic mediator of disciplinary meaning—a collaborative, interactive partner that helps students decode, experiment with, and master the intricate conventions of their specific fields.
This represents a profound paradigm shift in language education. The core educational value of GenAI does not reside in automating or replacing student writing, but in rendering the writing process radically more visible and profoundly more teachable. By externalizing the cognitive steps of drafting, refining, and justifying linguistic choices, AI tools transform abstract writing rules into tangible, hands-on learning moments. Students are empowered to move beyond passive consumption of language, becoming active, critical architects of their own academic and professional voices.
In conclusion, embracing GenAI in the ESP classroom requires a deliberate commitment to pedagogy over mere convenience. By championing transparent prompting and critical engagement, educators can harness these technologies to foster deep metalinguistic awareness and authentic genre mastery. As we look to the future of language teaching, our goal remains clear: to equip learners not just with the ready-made answers an AI can provide, but with the critical literacy to question, refine, and ultimately own the specialized discourse that will define their future careers.

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Language Teaching and Learning

The Future of Rhetoric in Public Speaking: L2 Education

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Abstract

Existing research on the rhetoric used in English-language speeches by Japanese activists is rare. Nevertheless, exploring the techniques which contribute to effective public discourse is vital to empowering Japanese speakers as they seek to disseminate their messages to a global audience. Therefore, this study conducts a rhetorical analysis of speeches by recent Japanese gender equality activists. A qualitative research design with descriptive data was employed, and the study was framed by the key research question: What are the rhetorical techniques and message-framing approaches utilized by Japanese gender equality activists? Speech transcripts from five Japanese TED Talk presenters were analyzed in two stages using MAXQDA 2020 software. Firstly, established rhetorical language techniques were identified and coded in the transcripts by using a modified version of the University of Kentucky's official glossary of rhetorical terms [1] as a framework for analysis. Secondly, the overall message-framing approaches [2] used by the speakers were analyzed. Findings indicate that the gender equality activists in this study used a range of rhetorical language techniques, often in combination, and that certain techniques were more prominent than others. Subtle patterns were also observed in how the speakers adhered to certain message-framing approaches to reinforce their speeches. The pedagogical implications drawn from these findings for English language instructors preparing presentation skills courses in Japanese higher education are then discussed.

Keywords: *Public speaking, Rhetoric, Second language teaching*

1. Introduction

The concept of rhetoric dates back to ancient Greece and the Sophists [3] but has evolved over more than 2,500 years. Rhetoric can be defined in public speaking as a technique where the speaker aims to sway the minds of the listeners and influence their opinions, decisions, or actions" [4]. Plato famously portrayed the use of rhetoric as disingenuous in many of his works, but others systematically described how rhetoric worked and catalogued a repertoire of techniques available to speakers. Aristotle later devised several models in his work, the *Art of Rhetoric*, most famously featuring the three types of proof: ethos, logos, and pathos [3]. Roman rhetors, such as Cicero and Quintilianus, later further modified our understanding of rhetoric. While Toye [3] disputes the notion that rhetoric largely disappeared during the Middle Ages, it did not play a prominent or significant role in society again until the last several hundred years, with the emergence of democratic states in the West and the age of reasoning. The relatively recent spread of the Internet and globalization has necessitated an even greater resurgent interest in rhetoric and the role it plays in shaping communication, particularly the digital forms, in all facets of our daily lives. While rhetoricians need to study rhetoric through a historical lens [5], it is also necessary to analyze and assess the current usage of rhetoric. One avenue of recent exploration is to determine the use of rhetoric outside the realm of the English-speaking world.

Aside from a few limited studies, little research has been conducted on the use of rhetoric in Japan. Okabe [6] notes that traditional adherence to cultural norms and collectivism has a significant impact on how Japanese speakers and their arguments are perceived. Research on English rhetoric in the Japanese context to date has largely focused on written texts and how they are structured or perceived, but findings do tentatively support Okabe's position of cultural differences shaping rhetorical approaches [7]. However, other studies have shown that these differences are frequently minimal when Japanese speakers use English. Miles [8] detailed how a small sample of Japanese activists utilized rhetorical techniques that mirror their Western counterparts. Additionally, a study by Feldman [9] uncovered how Japanese politicians frequently employed the all-too-familiar rhetorical strategy of equivocation when faced with potentially uncomfortable questions in interviews.

The Japanese Government has recognized the necessity of university graduates being able to communicate effectively in English if Japan is to maintain its competitiveness in a rapidly globalizing world [10]. Furthermore, according to Koike et al. [11], Japanese companies with international

connections need to hire graduates with practical English language skills for business negotiations and public speaking activities. University students also seem to know the necessity of learning public speaking skills [12]. While English language skills are taught to almost all Japanese students in their first year of university, until relatively recently, the focus has largely been restricted to reviewing basic grammar and developing daily conversation skills. Rhetoric seldom appears as part of the English language instruction in Japanese higher education.

Responding to needs and the government's initiative, researchers and instructors have begun to research and teach more English presentation and public speaking skills (particularly in university courses) in Japan in recent years. However, Omotedani and Sannomiya [13] stated that few studies have identified metacognitive knowledge regarding what learners or EFL teachers perceive constitutes a good oral presentation. The same researchers later showed that educational interventions can help facilitate improvements in presentation skills [14]. Oshima [15] detailed how TBLT could be used by Japanese university students in oral presentation preparation to encourage them to utilize all four skills—listening, speaking, reading, and writing—for a real-world purpose. Using smartphones to record, reflect, and practice presentations has also proven effective in increasing the quality of the final presentation [16]. Furthermore, rehearsing oral presentations has a positive impact on the speaking performances of students, by helping them identify and rectify their linguistic mistakes [17]. Showcasing public speaking skills at speech contests can be intrinsically motivating and provide students with perceived opportunities for personal growth [18]. One aspect of presentation skills that has not been explored in the Japanese context is how or if rhetoric can be a part of students' repertoire. In a recent study, Miles [19] showed that although rhetoric was briefly covered in some oral presentation skills courses in university English classes, it was never done so explicitly. The lack of rhetoric in Japanese university curricula is unfortunate, as one study in South Korea has shown that teaching rhetoric as part of traditional lectures enhances the academic performance of undergraduate business students [20]. If rhetoric becomes a more integral part of the English language curriculum in Japanese higher education institutions, it may help learners facilitate more effective interactions in society when they are part of the workforce (e.g., negotiating business deals, messaging government policies, and developing advertising strategies).

One other realm in which rhetoric can be important for speakers to utilize is social activism. One such example is the gender equality movement. While this movement has traditionally been more subdued in Japan [21], it is rapidly becoming more prominent and is already part of mainstream discussions in many other countries. Loosely defined as a movement focused on establishing equal rights for women, it is generally accepted that feminism started to take root in Japan with the opening of the country to outside influences during the Meiji Restoration in 1868. Women were given the right to vote in 1945, but it was not until 1999 that the Basic Law for a Gender Equal Society was passed in Japan. However, few public figures have been readily associated with the gender equality movement in Japan, other than Mitsu Tanaka, widely considered to have been the leader of the women's liberation movement since the early 1970s [22]. As in other countries, laws promoting gender equality in Japan have at times faced a backlash [23]. Partly because of this, the gender equality movement has progressed slowly in Japan, compared to neighbouring South Korea, with most Japanese activists remaining anonymous and advocating for modest goals [24]. Recently, however, videos of speeches advocating gender equality in Japan have become more readily available online. Learning about rhetoric through modelling these speeches allows Japanese university students to develop their own skills.

Given the dearth of research on the use of English rhetoric by Japanese speakers, there is a need for this study to establish whether rhetoric is employed in speeches and which rhetorical techniques are employed. Establishing the presence of rhetoric in speeches would allow instructors to then incorporate authentic materials in the classroom and begin to meet the government's desire to foster better English communication skills among students graduating from university.

2. Methodology

This study employs a qualitative research design, incorporating descriptive statistics, and is framed by the key research question: What are the English rhetorical techniques and message-framing approaches utilized by Japanese gender equality activists? The study represents a continuation of earlier research investigating the use of rhetoric across a range of different forms of activism in Japan [8]. However, the scope of this study is more refined and seeks to identify how Japanese gender activists utilize rhetoric when speaking in English and then proffer pedagogical lessons for educators seeking to enhance presentation skills classes in university English courses.

Five speeches were chosen following a strategic and purposive online search for TED Talk videos of Japanese activists speaking in English about gender-related issues. This represents a comparable case selection approach [25]. The speeches can be classified as examples of deliberative rhetoric (as defined by Aristotle) in that the speakers are making what they believe to be 'truth claims' in order to persuade an audience to take action [26]. The videos are readily accessible online, and details of the five speeches analyzed are provided in Table 1.

Table 1. Speeches analyzed in this study

Activist	Time	Speech title
1. Selina Shibata (2021)	7:49	"Gender Inequality in Japan"
2. Shu Matsuo (2021)	5:45	"Why Paternity Leave Benefits Everyone"
3. Kumi Sato (2014)	6:48	"Choices Women Make - Why Can't Japanese Women Have It All?"
4. Shiho Otomo (2017)	16:32	"Towards Gender Equality"
5. Rena Suzuki (2017)	11:16	"Why I Lean in and Become a Feminist"

A transcript of each speech was made by the researcher, with the accuracy verified through two subsequent viewings. The speeches were transcribed in chunks of language on separate lines, defined as complete utterances or phrases of language [27], instead of complete sentences, to more accurately reflect how the speech was delivered. Mistakes and false starts were transcribed verbatim, and utterances of Japanese words were simply written phonetically. The completed transcripts were then imported directly into the software program MAXQDA (version 2020), where they were coded. The coding process comprised two stages. In the first stage, the rhetorical language techniques were coded, adhering to definitions from the University of Kentucky's official glossary of rhetorical terms [1] with modifications to incorporate elements of Rowland's [28] model of language techniques. Table 2 provides a list of the rhetorical language techniques and definitions.

Table 2. Rhetorical language techniques

Language technique	Definition
Alliteration	Repetition of the same sound beginning several words in a sequence.
Allusion	An indirect reference to existing rhetoric, literature, history, or cultural norms.
Anaphora	Repetition of a word or phrase at the beginning of successive phrases.
Antithesis	Opposition, or contrast of ideas or words in a balanced or parallel construction.
Asyndeton	Lack of a conjunction between coordinate phrases, clauses, or words.
Euphemism	Substitution of an agreeable or at least non-offensive expression for one whose plainer meaning might be harsh or unpleasant.
Hyperbole	Exaggeration for emphasis of rhetorical effect.
Irony	Expression of something which is contrary to the intended meaning.
Metaphor	Implied comparison achieved through a figurative use of words.
Oxymoron	Paradox achieved by the juxtaposition of words which seem to contradict one another.
Paradox	An assertion seemingly opposed to common sense, but that may have some truth in it.
Personification	Attribution of personality to an impersonal thing.
Rhetorical question	A question that does not need to be answered.
Simile	An explicit comparison between two things using 'like' or 'as'.
Tricolon	The use of words, phrases, or clauses in patterns of three.

In the second stage of the coding process, the transcripts were coded for their message-framing approaches. As defined by Fairhurst [2], framing involves shaping the meaning of a subject or message, defining its character and significance, and emphasizing the overall message by including and excluding specific meanings. It can be considered a skill, and framing is "the capacity to be articulate and persuasive more or less on demand" [2: 30]. The message-framing coding process requires a holistic thematic coding approach, which, through coding "extended phrases and/or sentences" [29: 376], can identify values and concepts. The transcripts were coded twice to ensure accuracy. For the purpose of this study, framing can be considered as a seemingly indefinite series of dichotomies that encompass the overall theme of the message being promoted by the speaker. For example, a speaker campaigning for lower taxes could take either a positive framing approach (emphasizing the benefits to the economy and individuals of lowering the tax rate) or a negative framing approach (emphasizing the dangers of not reducing taxes). Another example of framing approaches includes a politician advocating for change, who could adopt a future-focused framing approach (emphasizing new policies to be implemented) or a past-focused framing approach (emphasizing a return to previous policies).

In a study that parallels gender activism, Gough [30] provides a rhetorical framework for analyzing the messaging in environmentalist speeches - another form of activism. Gough's two approaches, which essentially represent positive and negative framing, are called the 'garden scenario' and the 'wasteland scenario', respectively. Both are future-oriented approaches and present the audience with a choice for the future. In the garden scenario, "humans interact with the natural world to preserve and manage it" [30: 52], while in the wasteland scenario, "human activity destroys the earth" [30: 52]. To achieve their goals, environmental activists present the audience with another choice. Humanity can either adopt top-down strategies (starting with change on the international stage and from the governmental level) or bottom-up strategies (starting with change from individuals). For this study, framing approaches related to the concept of 'change' were coded, as this pertains to the main objective of activists' speeches. Gough's definitions were modified to more accurately reflect a gender equality focus. Table 3 contains the six framing approaches and their definitions.

Table 3. Framing approaches

Framing approach	Definition
Positive framing (Garden scenario)	Emphasizing the benefits to be gained by taking action.
Negative framing (Wasteland scenario)	Emphasizing the drawbacks and problematic consequences resulting from inaction.
Top-down strategies	Placing the onus for taking action on international bodies or national governments.
Bottom-up strategies	Placing the onus for taking action on individuals in society.
Future-focused framing	Emphasizing a forward-looking approach to addressing issues.
Past-focused framing	Emphasizing a backward-looking approach to addressing issues.

Figure 1 provides a screenshot from Selina Shibata's transcript (LL5-10) to illustrate the coding process.

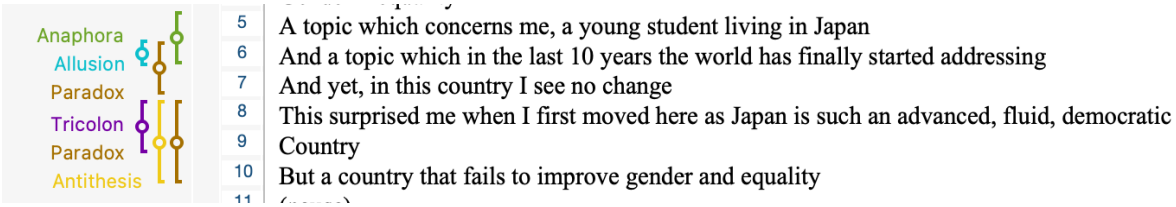


Figure 1. Coding example

3. Findings and Discussion

The key finding in this study is that rhetoric (both language techniques and message-framing approaches) was prominent in all the speeches analyzed. Some aspects of rhetoric featured more often than others, and there are key pedagogical takeaways from these findings. Findings relating to the rhetorical language techniques (Stage 1) will be detailed first. The frequency counts for the language techniques coded in the five speeches are presented below in Table 4.

Table 4. Language technique results

Technique	Kumi Sato	Rena Suzuki	Selina Shibata	Shu Matsuo	Shiho Otomo
Alliteration (3)	1	1	1	0	0
Allusion (15)	2	4	5	1	3
Anaphora (21)	2	7	6	1	5
Antithesis (27)	2	15	5	0	5
Asyndeton (3)	0	0	1	1	1
Euphemism (5)	0	3	2	0	0
Hyperbole (11)	3	2	2	3	1
Irony (5)	1	1	2	0	1
Metaphor (13)	0	5	2	5	1
Oxymoron (0)	0	0	0	0	0
Paradox (8)	0	0	4	2	2
Personification (2)	0	1	0	0	1
Rhetorical question (22)	8	3	4	0	7
Simile (6)	0	5	1	0	0
Tricolon (15)	3	3	1	3	5
Totals (156)	22	50	36	16	32

The most significant finding from this frequency count is that all five speakers utilized a wide range of rhetorical language techniques, with each speaker using more than six different techniques. In total, Rena Suzuki exhibited 50 instances of rhetorical language techniques, while Shuo Matsuo exhibited only 16. Given that he spoke for just under six minutes, this still equates to more than two language techniques per minute. In terms of the overall frequency, the techniques most commonly used by the speakers were antithesis (27), rhetorical question (22), and anaphora (21). All three of these techniques are simple to use and typically serve an emphatic purpose in speeches. Tricolons (15) were used frequently and also generally serve to emphasize the speaker's message. Interestingly, one speaker (Shu Matsuo) did not use either an antithesis or a rhetorical question.

The only technique not used in any of the speeches was an oxymoron. Other infrequently utilized techniques were personification (3), alliteration (3), and asyndeton (3). Irony (5), euphemism (5), and simile (6) were also not employed often. Many of these techniques can be described as more 'poetic', rather than emphatic, thereby potentially undermining the speaker's sincerity towards a sensitive topic, such as gender equality, if overused. This possible explanation is supported by the finding that the sole male speaker in the study used far fewer techniques than the four female speakers. When considering how the audience perceived his ethos, he was possibly aware of his potentially delicate position as a male speaker, speaking about women's rights, and therefore adopted more of a factual and explicitly sincere approach, which was less reliant on rhetoric.

In the second stage of the study, the speakers' framing approaches were coded. Table 5 provides the frequency counts for coded instances of each speaker's framing approach.

Table 5. Framing approach results

Framing approach (total)	Kumi Sato	Rena Suzuki	Selina Shibata	Shuo Mastuo	Shiho Otomo
Positive framing (18)	1	4	0	10	3
Negative framing (22)	4	6	5	1	6
Top-down strategies (2)	0	0	1	1	0
Bottom-up strategies (14)	2	3	3	1	5
Future-focused framing (7)	3	3	0	0	1
Past-focused framing (2)	0	1	0	1	0
Total (65)	10	17	9	14	15

The findings above reveal that each speaker favoured different underlying approaches to delivering similar messages, with most relying on a combination of framing approaches. Primarily, the speakers employed positive and negative framing to contrast their message of reality with an ideal position. Encouraging a bottom-up approach as a solution, especially at the end of their speeches, was another common tactic. The female speakers tended to use more negative message-framing approaches, often punctuated with personal anecdotes, whereas the male speaker focused primarily on positive framing, supported by anecdotes that showed his more enlightened approach to gender issues and the subsequent positive effects he envisioned if others adhered to a similar approach. While he may have utilized relatively fewer rhetorical language techniques, the frequency of his use of framing approaches mirrored that of the female speakers.

Two framing approaches rarely utilized were top-down strategies and past-focused framing. The latter is not surprising, as the speakers viewed the current status quo for gender rights as inadequate at best, and they were all advocating for a better future, not for a return to the past. The lack of top-down strategies presented was surprising and stands in contrast to climate change activists, who frequently urge national governments to take action. Instead, the activists advocated for a bottom-up approach.

To better illustrate the framing approaches used by the speakers, two examples are provided below in Table 6 for each approach. Each quote is referenced according to the lines in the respective transcript from which it was drawn. Commas have been added to the quotes to assist the reader.

Table 6. Message framing examples

Speaker	Positive framing excerpts
Rena Suzuki	I'm glad to have my husband calling himself feminist, and we are both feminists, because we want each other to have the same options, either me pursuing my career, or him becoming a stay-at-home dad (LL146-148)
Shu Matsuo	men who take paternity leave experience a stronger bond with their babies, research shows that the longer the paternity leave, the more engaged the father is in the first few years of a child's life (LL38-40)
	Negative framing excerpts
Kumi Sato	now, given that we have an aging population, where one of four people are going to be over 65, is it really fair for the wife or the daughter, to ask somebody, or a parent, who is 65 or older to be chasing a toddler and doing household chores (LL25-27)
Selina Shibata	these problems pile up one after the other and this whole system just seems like a trap (LL64)
	Top-down strategies
Selina Shibata	the government has to focus on providing a flexible environment for working parents (LL92)
Shu Matsuo	we need more countries to set up systems that allow all parents to take paid childcare leave (LL88)
	Bottom-up strategies
Kumi Sato	so, if you believe in this and agree with me, let's voice this and talk to people, so one day, maybe, a public policy maker will agree with it and something will be made to change it (LL76-77)
Selina Shibata	that is why I am reaching out to all the Japanese women out there, we have a voice and we must put it to use, we must come together to create gender equal society (LL99-101)
	Future-focused framing
Rena Suzuki	so I said to my boyfriend at that time that I wanted to change the society so that all women and men can be truly equal (LL17-18)
Shiho Otomo	we can make improvements by making small changes around us, these small changes we make will become a seat for a worldwide movement (LL161-162)
	Past-focused framing
Rena Suzuki	I went Keio because I wanted to achieve something great, and wanted to have a successful career in business, so imagine my surprise when I hear about the research showing that 80% of female co-eds at my faculty wanted to become housewives (LL35-38)
Shu Matsuo	like most men in Japan, I grew up being told that masculinity is supposed to look a certain way, you're supposed to be stoic and strong, dominant and in control; the breadwinner for your family (LL9-10)

Attention can now be turned to more conclusively addressing the research question framing this study: What are the rhetorical techniques and message-framing approaches utilized by Japanese gender equality activists? Overall, it can be said that the speakers frequently utilized rhetoric in their speeches, both in terms of rhetorical language techniques and overall message-framing approaches. There are also additional related sub-findings and distinctions worth noting.

Firstly, all five speakers utilized various rhetorical language techniques in their speeches. They employed them to punctuate their messages, to make their arguments more persuasive, and to engage with the audience. A closer analysis revealed that the simpler and more emphatic techniques were utilized more frequently. This is not surprising as such techniques are relatively simple to implement, especially for L2 speakers. Additionally, the underlying purpose of the speeches was to persuade the audience, and as such, emphatic techniques were likely considered more appropriate by the speakers, demonstrating an acute awareness of how to use rhetoric. Also potentially significant is that many of the rhetorical language techniques utilized by the speakers in this study closely mirror those typically used by Western speakers in similar such speeches [31]. This finding suggests that rhetoric could be determined more by the language being used than by the cultural background of the speaker.

Secondly, the use of a wide range of message-framing approaches was evident in all the speeches, and they were often used in combination. They were typically interwoven throughout the speech, with the most vivid example being the contrast between the ideal world where gender equality is realized (positive framing) and the reality of the current situation (negative framing). Western activists incorporate similar combinations in their speeches [31]. Interestingly, the gender equality activists exhibited differences from climate change activists concerning which message-framing approach they prioritized (bottom-up approaches instead of top-down approaches and less reliance on future-focused framing). Additionally, gender differences were found between how the male speaker framed his speech and how the female speakers framed their speeches (more focus on positive framing).

The limited scope of the investigation precludes any definitive conclusions from being established until further work is conducted. Nevertheless, it can still be concluded that despite differences in how each speaker delivered their message, all five activists featured in this study delivered a strong rhetoric-infused message that largely mirrored the approaches and techniques found in speeches outside of the Japanese context [31]. The study can also conclude that the form of activism likely shapes the message-framing approach adopted by the speaker. This suggests an avenue for further research, exploring the rhetorical approaches of speakers outside Japan and across differing genres of activism.

4. Implications

Pedagogical implications for language learners and educators can be drawn from this study. While it has been traditionally argued that for learners to competently utilize rhetoric, a significantly high level of English proficiency is required, this study suggests otherwise. Two of the speakers analyzed in this study were high school-aged, and none of the speakers could be described as completely fluent. None of the five speakers is considered a professional speaker, yet all implemented rhetorical techniques frequently throughout their speeches. From this, it could be inferred that learning such techniques is not beyond the reach of L2 learners at the university level. Furthermore, rhetorical techniques are often more compelling when composed of simple English vocabulary. The vast majority of the language techniques coded in this study exemplified this point. For language instructors, videos of these speeches offer a chance to provide learners with materials to analyze. Modelling the techniques and approaches found in these speeches (and others) would represent the incorporation of authentic materials into the learning process, which is known to facilitate language learning [32]. It would also illustrate for L2 learners in higher education that rhetoric is simple to implement in public speeches.

Although rhetoric may appear relatively easy to implement into language courses in Japanese higher education, one daunting obstacle is that language educators in Japan often possess little background training in how to teach rhetoric - it is seldom covered in L2 training courses. This issue needs to be addressed first before rhetoric can be featured in second language curricula at the university level [19]. Awareness of this fact would be the first step. Given the frequency with which second language learners are required to present in English in Japanese university courses [11], successfully infusing rhetorical techniques into their presentations should be considered a mandatory skill to learn.

The findings from this study also proffer implications for activists. As the speakers in this study largely exhibited similar rhetorical techniques and approaches to activists outside Japan [31], it can be assumed that rhetoric has a universal appeal extending beyond the domain of Western nations or English-as-a-first-language speakers. Findings from this study also suggest that the appropriateness of the techniques used by activists can fluctuate according to the genre of activism. Japanese activists need to learn to synthesize their approaches and techniques with the expectations of the audience when pitching their climate change, gender equality, or poverty relief messages.

5. Conclusion

This study demonstrates that the use of rhetoric (language techniques and message-framing approaches) is not the sole domain of speakers for whom English is a first language. L2 activists also use rhetoric as a tool for public speaking, often in a similar manner as their Western counterparts. However, to support Japanese speakers using English in the public realm, rhetoric needs to be seen as more than a peripheral subject when taught in higher education English language courses in Japan.

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Embodied Language Learning in the Age of AI: Insights from Five Years of Scaffolded Language Emergence

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Abstract

What is the place of physical elements in the language classroom in the age of artificial intelligence? This paper summarizes the results of five years of implementing the Scaffolded Language Emergence (SLE) approach in foreign language teaching, with a particular focus on the role of physical elements in learning. SLE is an approach that promotes language emergence in adult learners and was developed by Dr. Donald Kiraly at the University of Mainz. To date, it has been applied to more than fifteen languages, including minority and endangered languages.

The paper presents experiences from the Institute of Applied Language Studies at the University of West Bohemia in Pilsen, where SLE has been used in foreign language instruction, as well as its application in supporting the teaching of Lower Sorbian, an endangered West Slavic minority language. Drawing on concrete classroom examples, the paper demonstrates how physical interaction, movement, objects, and other embodied activities contribute to learner engagement, meaning-making, and sustained language development.

The findings underscore the continued importance of face-to-face teaching contexts that facilitate the integration of physical elements, particularly at a time when language instruction is increasingly shifting to virtual environments. The paper argues that embodied, socially situated learning practices offer distinct advantages that complement digital and artificial intelligence–based learning tools, and that SLE provides a viable framework for maintaining these benefits in contemporary language education, offering also critical advantages for the revitalization, maintenance, and teaching of minority and endangered languages.

Keywords: *SLE, Scaffolded Language Emergence, language learning and acquisition, language teaching, embodied activities*

1. Introduction

The rapid expansion of artificial intelligence (AI) in education has significantly transformed language learning environments. AI-driven tools now offer adaptive feedback, automated assessment, and personalized learning pathways, reshaping how languages are taught and acquired. While these developments bring undeniable advantages, they also raise important questions about what may be lost as language learning increasingly shifts toward virtual, technology-mediated contexts.

One key concern is the diminishing role of physical, embodied interaction in the language classroom. Language is not only a cognitive system but also a socially and physically situated practice, deeply connected to movement, gesture, space, and material interaction. In this context, approaches that foreground embodiment may offer valuable counterbalances to purely digital learning environments.

This paper explores the role of physical elements in language learning through the lens of Scaffolded Language Emergence (SLE), an approach developed by Donald Kiraly. Drawing on five years of implementation at the Institute of Applied Language Studies at the University of West Bohemia in Pilsen (UWB) and in the high school context, the study examines how embodied activities contribute to learner engagement, meaning-making, and sustained language development. It also considers the relevance of SLE in teaching minority and endangered languages, with particular reference to Lower Sorbian.

The paper addresses the following research questions:

- How do embodied activities support language emergence?
- What is the role of SLE alongside AI-based tools?
- How can embodied approaches contribute to the teaching and revitalization of minority languages?

2. Theoretical Background

2.1 Language Learning in the Age of AI

AI has become a central component of modern language education. Empirical studies report a medium-to-large overall effect on language learning outcomes, with the strongest impact on vocabulary, followed by reading, writing, listening, and speaking. At the same time, these findings highlight limitations, indicating that explicit instruction and scaffolding remain necessary, particularly for skills requiring long-term practice or metacognitive control [19].
AI-based learning environments often lack the social and embodied dimensions characteristic of face-to-face interaction. Although some studies explore integrating AI into physical activities [8], these solutions are not yet widely accessible in educational settings.
According to Ethnologue, a research institution that extensively studies the survival of the world's languages, 44.6% of the world's 7,170 living languages are currently endangered [2]. While AI performs well in high-resource languages, its application to minority and low-resource languages remains limited due to data scarcity, lower performance, and insufficient cultural contextualization. These constraints limit its ability to capture the social and embodied nature of language learning.
AI should therefore be regarded as a complementary tool rather than a substitute for human-centered, community-based approaches, particularly in the preservation and teaching of endangered languages.

2.2 Embodied Cognition and Language Learning

Embodied cognition emphasizes that cognitive processes are grounded in bodily experience and interaction with the environment. In the context of language learning, this perspective highlights the role of movement, gesture, and sensory engagement in constructing meaning.
Empirical research has demonstrated that learning through physically meaningful interaction – such as role-play, drama-based techniques, arts-based activities, object manipulation, and movement-oriented tasks – can positively influence multiple aspects of language development, including vocabulary acquisition, grammatical competence, and pronunciation. Furthermore, such approaches have been associated with improvements in memory retention, comprehension, and affective factors, including learner motivation and emotional engagement.
A systematic review of studies published between 2019 and 2020 [3] indicates that embodied approaches to language learning can facilitate holistic learner engagement while supporting the development of key language competencies. At the same time, the review identifies several gaps in the existing research, particularly regarding the application of embodied learning in secondary education contexts and its impact on intermediate and advanced learners beyond vocabulary acquisition.

2.3 Scaffolded Language Emergence (SLE)

The SLE approach was developed by Donald Kiraly during his tenure as a senior lecturer at the School of Translation, Linguistics and Cultural Studies (FTSK) at the University of Mainz. Conceived as an andragogical approach to additional language acquisition, SLE emerged from approximately fifteen years of pedagogical experimentation with a range of language teaching methods, including the Silent Way, the Structural-Global-Audio-Visual approach, the Natural Approach, the Whole Language Movement, Suggestopedia, and Communicative Language Teaching [6], including also Total Physical Response [4].
SLE foregrounds the co-construction of language through social interaction and guided participation. In contrast to approaches that prioritize explicit instruction and predefined learning outcomes, SLE emphasizes emergent language use, learner agency, and collaborative meaning-making. The approach is grounded in a set of pedagogical assumptions about adult language learning, from which a series of didactic precepts are derived [7].

Table 1. SLE assumptions and didactic precepts [7]

ASSUMPTIONS	PRECEPTS
1. Percieved authenticity aids motivation	Seek authenticity and encourage authentication
2. Linearity constrains learning	Embrace complexity in the classroom
3. Affordances rather than input are the primary stimuli for learning	Take advantage of affordances rather than merely trying to provide input
4. Knowledge is often socially constructed	Promote autonomy and collaboration, provide scaffolding
5. Language is embodied	Emphasize linguistic/corporeal connections
6. Affect is a key factor in learning	Welcome emotions in classroom activities
7. Grammaticalization depends on induction and abduction	Encourage inductive and abductive reasoning

These principles are operationalized holistically in the SLE classroom. Embodied learning plays a central role, as activities are designed to integrate physical movement with language use, thereby activating motor memory and reinforcing learning processes. Learners engage in physically grounded tasks, ranging from simple commands (e.g., “sit down”, “stand up”) to more complex sequences involving coordinated actions (e.g., “touch your toes with your hands”, “take three jumps forward”).
A wide range of activity types can be incorporated into the SLE framework, including classroom objects, miming, role-playing, acting out stories, spatial navigation tasks (e.g., fly swatters, labyrinths), and simulations of real-world environments. Whenever possible, learning is extended beyond the classroom through engagement with authentic settings where the target language is used [4] [5] [7]. The learning environment itself is treated as flexible and dynamic: students may work in circles or semicircles, and classroom space can be reorganized to support interaction and participation. In this context, the teacher assumes the role of facilitator rather than instructor, guiding complex, emergent activities shaped by learner interaction. For this reason, SLE is more appropriately described as an approach rather than a method.
The SLE approach was successfully implemented at the University of Mainz between 2013 and 2019 in courses introducing translation students to fifteen different languages. Subsequently, between 2020 and 2022, further development took place through a series of intensive workshops at the Institute of Applied Language Studies at UWB in the Czech Republic. These workshops, conducted by Kiraly and colleagues, included instruction in Spanish, English, Italian, Russian, and Czech. As part of this initiative, a series of didactic videos demonstrating SLE principles was produced and later integrated into the university's regular study programs [12] [13] [14] [15] [16] [17] [18]. The author of this paper also implemented SLE in high school teaching.

2.4 Lower Sorbian

Among the languages employed in the series of exemplary language classes at the UWB was Czech, a West Slavic language closely related to Lusatian Sorbian. Lusatian Sorbian (Lower and Upper) is classified as an endangered minority language. The Czech Republic maintains historical and geographical ties to the region of Lusatia, which is primarily located in Germany and Poland but also extends marginally into Czech territory. Efforts to preserve and promote the Lusatian Sorbian language and culture have a long-standing tradition in the Czech Republic, notably through the activities of the Spolek přátel Lužice (Society of Friends of Lusatia), which organizes cultural events and maintains dedicated resources, including a website and library.
In the Lusatia region, Lower Sorbian is currently spoken fluently by approximately 400 speakers. In response to the ongoing decline of the language and its associated cultural practices, the Sorbian community has intensified efforts to raise awareness of its linguistic and cultural heritage. Within the formal education system, a key institution is the Niedersorbisches Gymnasium (NSG) in Cottbus, established in 1952. This bilingual secondary school requires all students to achieve proficiency in Lower Sorbian by the completion of their studies and currently enrolls approximately 500 students. However, concerns regarding the effectiveness of instructional methods in Lower Sorbian education have been documented [9].
A significant recent initiative is the Zorja project, launched in 2022 by Maximilian Hassatsky, a specialist in the Lower Sorbian language and culture. Supported by a €2.5 million grant from the German government over a nine-year period, the project aims to develop advanced proficiency (C1 level) in Lower Sorbian among adult learners. Its long-term objective is to increase the number of fluent speakers by approximately 1,000 by 2040. The program is designed as an intensive course comprising 30 hours

of instruction per week over ten months, supplemented by a one-month internship at a Sorbian institution and by independent research.
During the preparatory phase, a range of language-teaching approaches was evaluated to foster communicative competence, positive learner attitudes, and sustained intrinsic motivation. Following this review, the Zorja teaching team adopted the SLE approach on a trial basis, particularly during the initial 150 hours of instruction. This initiative represents the first known attempt to systematically implement the SLE approach within a long-term foreign language learning program [20].
The need for increased attention to pedagogical approaches in the preservation of Lusatian Sorbian is further underscored by the limited scope of existing research. Previous studies have predominantly addressed linguistic aspects, including phonetics, lexicon, syntax, grammar, and etymology. Sociolinguistic aspects of Lower Sorbian [1] have also been explored in previous research, alongside studies examining the regional distribution of speakers [10] and the training of specialists at the Institute of Sorbian Studies at the University of Leipzig [11]. However, there remains a notable gap in research concerning teaching methodologies and instructional practices.

3. Methodology

3.1 Research Context

This study draws on five years (2021-2025) of implementing the SLE approach at the Institute of Applied Language Studies at UWB and in a high school context (Conservatory of Pilsen). Additional data were collected during the initial phase of the Zorja project. The research involved high school, university, and adult learners with diverse linguistic backgrounds and covered both regular foreign language courses and an intensive course format.

3.2 Data Collection and Analysis

Data on the implementation of the SLE approach, which incorporates physical elements, were collected through two primary methods: a final questionnaire administered to participants and classroom observation conducted during the teaching process. The final questionnaire was not specifically designed to investigate physical activity; however, it included items assessing perceived effectiveness and satisfaction with the teaching approach.
A qualitative research design was adopted to identify recurring patterns in embodied interaction, learner engagement, and language emergence. The analysis aimed to relate observed practices to relevant theoretical frameworks, particularly those of embodied cognition and the SLE approach.

4. Findings

4.1 SLE in High School Context

The students were asked to identify which aspects of their classes they would retain, modify, or eliminate. Of the 31 respondents, 8 indicated that they would keep all aspects of their classes, expressing general satisfaction without further elaboration. A further 18 students explicitly highlighted the teaching methods, particularly those incorporating “games,” “interesting activities,” and “interactivity.” These were described as “an original and active way of presenting the material,” with comments such as: “I always enjoy games invented by the teacher more than exercises from the workbook.”
Several responses emphasized the physical dimension of these activities, which students associated with game-based learning. Representative statements included: (a) “group and physical activities,” (b) “group work and not sitting at desks at the beginning of class, working with the interactive whiteboard, creative lessons, and games,” (c) “various activities during class (games, exercises in the classroom, etc.),” (d) “lots of practice activities, interactivity, playing theater,” (e) “group interactions (games, conversations, etc.) and dancing or any other movement,” and (f) “the fact that we don’t sit at our desks the whole class, that we actually learn through play, and that we talk more than we write.”
In the remaining five cases, students referred to aspects unrelated to physical activity, such as speaking predominantly in the target language, using visual materials, working with textbooks, incorporating songs, and engaging in conversation. Only one student expressed a preference for a more traditional instructional approach, stating: “I prefer the traditional school system; I don’t feel the need for lessons in the form of fun activities like games, flashcards, or memory games.”

When asked what they would change, 13 out of 31 students reported that no changes were necessary. The remaining responses did not emphasize physical activity; instead, they included requests such as more systematic note-taking of grammar (n = 4), increased use of textbooks (n = 3), more music and songs (n = 3), and greater inclusion of films and videos (n = 2). Other suggestions appeared only once (e.g., more conversation, more frequent testing, use of Kahoot, digital textbooks, and translation of teacher instructions). Only one student explicitly requested an increase in physical activities.
Regarding elements to be omitted, 21 out of 31 students indicated that nothing should be removed. Four students suggested eliminating textbooks and workbooks. Other isolated suggestions included reducing activities in which only a few students are active, limiting vocabulary testing on the interactive whiteboard, avoiding reading aloud when called upon, and excluding creative text-composition tasks. Only one response referred to removing a movement-related activity ("facial expressions and gestures").

4.2 SLE in University Context

During the five-year period under review, only a small percentage of the total 275 students – between 0 and 20 % per semester – participated in the final evaluation. Students expressed overall satisfaction with the course (content, teaching methods, format, and credit hours), with an average of 88 %. For the statement "I was impressed by the instructor's approach during the class/seminar," the response was selected in 100 % of cases.
The open-ended responses included comments such as: "A very engaging course. I was apprehensive at first, but my concerns proved unfounded. The professor has a very creative approach to teaching, which is highly interactive and gave me a new perspective on how a foreign language can be taught. The classes were playful and interactive, yet packed with information." The comments also mentioned how "fun" the classes were and the fact that the students "enjoyed the lessons," as well as how easy the material was to remember: "I was able to easily remember the material thanks to plenty of repetition during group work, mini-interviews, and games. Every class was interesting in its own way."
None of the comments specifically mentioned physical activities, but the methodological approach was viewed positively as a whole: "I really enjoyed the teaching methods. Every lesson was carefully prepared; we always played different games and did fun activities that helped us practice what we'd learned, and none of them were repeated throughout the entire semester – I really appreciate that. Not only did the lessons give me a great foundation in the language, but I'm also taking away lots of ideas for activities I can use when teaching a foreign language."
None of the comments that raised objections (teaching in the target language from the very beginning, the lack of structured grammar notes in the workbook) concerned the inclusion of physical activities in the learning process.

4.3 SLE in Lower Sorbian Context

After completing 150 hours of instruction using the SLE approach, the respondents (N = 10) were asked to evaluate the extent to which their communicative competence had improved. The majority reported positive development: 5 respondents indicated that their competence had "greatly improved," and 4 reported it had "considerably improved." Only 1 respondent perceived very little improvement, and none expressed uncertainty.
Regarding the main focus of instruction, the majority of respondents (n = 7) perceived a balanced approach between language structure and communication, while 3 indicated that the focus was mainly on communication. None reported a primary emphasis on language structure or expressed uncertainty.
The perceived effectiveness of the teaching approach was highly positive. Six respondents rated it as "amazingly effective," and 3 as "very effective," while only 1 considered it "fairly effective." None of the respondents evaluated the approach as ineffective or not very effective.
Similarly, respondents strongly agreed that the teaching team had adopted an effective approach. Eight respondents indicated that this was achieved "to a great extent," while 2 selected "to a moderate extent." No respondents expressed negative evaluations or uncertainty.
Finally, when asked which aspects of the teaching approach might require improvement, responses were more varied. Three respondents did not provide an answer. Among the remaining responses, communicative practice was mentioned by 3 respondents, while both collaboration among teachers and grammar instruction were each identified by 2 respondents.

4.4 Classroom Observations

Observations indicate that incorporating physical elements into classroom instruction can enhance student engagement compared to more passive learning situations, in which students remain seated – often partially obscured behind desks or computer screens.
A comparison across the observed sample suggests that integrating physical activities is generally more straightforward with younger learners. Adult learners, by contrast, may initially experience discomfort or hesitation. For this reason, it is advisable to clearly explain the rationale and potential benefits of incorporating movement-based activities into the learning process. At the same time, teachers should remain attentive to the group's needs and adapt activities flexibly to ensure a supportive learning environment.
The following types of activities have been implemented repeatedly and have received positive feedback:

- exercises involving body awareness and movement (e.g., warm-up activities at the beginning of class, coordination exercises aimed at integrating brain hemispheres)
- interaction with physical objects (e.g., pointing to, touching, lifting, or manipulating items)
- movement-based tasks such as running or quickly locating items (e.g., using fly swatters, images, objects, or information fixed on classroom walls)
- miming and dramatization of stories (e.g., daily activities, basic hygiene, study activities)
- spatial navigation activities within the classroom (with eyes open or closed)
- role-playing and simulations of real-life situations (e.g., purchasing tickets, ordering food)
- hands-on practical activities (e.g., simple cooking tasks)

5. Discussion

The findings across the high school, university, and Lower Sorbian contexts indicate that the SLE approach was perceived positively by learners of different ages and educational settings. In the high school context, students particularly appreciated interactive, game-based teaching methods, often referring to movement, group work, dramatization, and activities outside the traditional desk arrangement. These responses suggest that learners associated effective and enjoyable language learning with active participation and social interaction.
The university findings support these conclusions. Students described the classes as engaging, creative, interactive, and memorable, often emphasizing how games, repetition, and collaborative activities helped them retain the material more effectively. Interestingly, respondents rarely referred directly to physical movement itself; rather, they evaluated the teaching approach as a whole. This may suggest that, in adult education, movement-based activities become integrated into broader communicative methodology rather than being perceived as separate techniques, in accordance with the SLE theoretical framework. Some comments also indicated that students were initially uncertain about the unconventional format but later evaluated it positively after experiencing its benefits.
Similarly, the Lower Sorbian data demonstrated highly positive perceptions of communicative improvement and instructional effectiveness. Most respondents considered the instruction balanced between communication and language structure, suggesting that the SLE approach did not lead learners to perceive grammar instruction as neglected. Nevertheless, some participants still identified communicative practice and grammar explanation as areas requiring further development, again highlighting the importance of balancing experiential and form-focused instruction.
The classroom observations further confirmed that incorporating physical activities can increase student engagement and participation compared to more passive learning situations. Activities involving movement, role-play, dramatization, object manipulation, and spatial interaction were consistently received positively. However, the observations also suggested that younger learners adapted more naturally to movement-based instruction, whereas adult learners sometimes showed initial hesitation. This highlights the importance of creating a supportive classroom environment and clearly explaining the purpose of embodied activities when implementing SLE with older learners.

6. Implications for Language Teaching

While AI tools offer valuable support for language learning, they cannot fully replicate the embodied and socially situated nature of SLE practices. A balanced integration of AI tools and embodied approaches offers a promising direction for language education. Hybrid models can combine the strengths of both, ensuring flexibility without sacrificing depth of learning.

SLE ensures that learners engage in meaningful, context-rich interaction that supports deeper learning. Classes that incorporate physical activity can be perceived as playful, fun, and interactive. Language teachers – especially but not only at the high school level – should consider incorporating:

- Movement-based activities
- Use of physical objects
- Spatially organized tasks

Embodied approaches are particularly valuable in teaching minority and endangered languages. They support cultural transmission, community building, and meaningful engagement, all of which are essential for language maintenance.

7. Conclusion

This paper examined the role of physical and embodied elements in language learning through five years of implementing the Scaffolded Language Emergence (SLE) approach in high school, university, and minority-language contexts. The findings indicate that learners generally perceived SLE positively, particularly valuing its interactive, communicative, and experience-based character. Activities involving movement, role-play, games, dramatization, object manipulation, and spatial interaction were associated with increased engagement, enjoyment, and memorability of the learning process. At the same time, the results demonstrated that learners also continue to value explicit structure and grammar support, suggesting that embodied approaches are most effective when balanced with more systematic instructional elements.

The study further confirms the relevance of embodied cognition theories in contemporary language education. Classroom observations and learner responses suggest that physical participation can support attention, emotional involvement, social interaction, and meaning-making in ways that extend beyond purely cognitive or screen-based learning environments. These findings are particularly significant in the context of increasing digitalization and the growing presence of artificial intelligence in language education. While AI-based tools provide important advantages, including adaptive feedback, individualized practice, and flexible access to learning materials, they cannot fully replicate the embodied, interpersonal, and socially situated dimensions of language learning observed in SLE classrooms.

The findings are also relevant for the teaching and revitalization of minority and endangered languages, such as Lower Sorbian. In such contexts, language learning is closely connected to community, identity, and cultural practice. Embodied and collaborative activities may therefore play an important role not only in developing communicative competence but also in strengthening learner motivation, social belonging, and meaningful engagement with the language. The positive evaluations of the Zorja project participants suggest that SLE offers considerable potential for long-term minority-language education focused on communicative use and sustainable learner involvement.

Rather than positioning embodied learning and AI-driven learning as competing paradigms, this paper argues for their complementary integration. AI tools can effectively support repetition, vocabulary development, pronunciation practice, and autonomous learning, while embodied approaches such as SLE contribute social interaction, contextualized communication, emotional engagement, and physical experience. Future language education may therefore benefit most from hybrid models that combine technological innovation with human-centered, embodied pedagogy. In this respect, SLE represents a valuable framework for preserving the interpersonal and experiential dimensions of language learning in an increasingly digital educational landscape.

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Honoring Human Variation at Scale: Reimagining School through Facilitated Interdependent Learning

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Abstract

Facilitated Interdependent Language Learning (FILL) is a proficiency-centered approach to world language education that replaces pacing guides and teacher-directed curricula with a flexible system organized around what learners can do with language. In a FILL classroom, instructional authority shifts decisively toward the learner: students choose the language and topics they wish to study, set proficiency-based goals, select resources, and reflect on their progress, while the certified teacher operates as a facilitator who designs the conditions for language acquisition rather than directing daily learning. Graduation credit is earned through demonstrated proficiency rather than seat time, positioning learners as accountable agents in their own growth. Students function as autonomous yet interdependent learners, articulating proficiency targets through NCSSFL/ACTFL Can-Do Statements [1] aligned with ACTFL proficiency frameworks [2]. Proficiency serves as both the organizing principle for learning and the primary metric for assessment, prioritizing communicative ability over content coverage. Artificial intelligence plays a central, transformative role by enabling personalization at scale: learners use AI to generate level-appropriate texts, design individualized practice, explore linguistic structures, and engage in written and spoken interaction aligned to their goals and interests. Positioned not as a shortcut but as an adaptive learning partner, AI supports exploration, strategy development, and iterative refinement. Rigor and transparency are ensured through externally benchmarked proficiency assessments (e.g., Avant's STAMP test), providing independent validation of growth and allowing proficiency to carry institutional meaning beyond the classroom. This session presents FILL as a transferable framework with implications extending beyond world language education, demonstrating how learner-centered, AI-supported, proficiency-based systems can expand access to less commonly taught and heritage languages without adding staffing or programs. For under resourced schools in particular, FILL offers a sustainable model for broadening opportunity, preserving rigor, and redistributing power toward learners while maintaining accountability at scale.

Keywords: *Facilitated Interdependent Language Learning; AI-Assisted Language Learning; Language Access; Welch*

Introduction

1. The Persistence of Structure

"So… what are we learning this week?"
The familiarity of the question lies not in its content, but in the assumptions it carries. It presumes that learning has already been determined, sequenced, and owned by the system. When the response shifts to "What do you want to be able to do?", the underlying architecture begins to change. The focus moves from content delivery to capability, from curricular coverage to learner intention.
This shift is occurring against a backdrop of profound transformation. Learners now inhabit environments saturated with access to information, tools, and global networks. Artificial intelligence has accelerated this transformation, offering learners the ability to generate explanations, engage in simulated interaction, and receive immediate feedback. Knowledge is no longer bounded by institutional walls; it is distributed across platforms, communities, and contexts.
Yet despite these changes, the structural features of schooling remain largely intact. Courses continue to define what is to be learned, calendars determine when, and grades serve as proxies for success. These structures persist not because they reflect how learning occurs, but because they provide administrative coherence.
The central question, then, is not whether learning has changed. It has. The question is whether the systems designed to support learning have evolved accordingly. This paper argues that they have not, and that meaningful progress requires a shift from refining instruction within existing structures to

reimagining the structures themselves. Facilitated Interdependent Language Learning (FILL) is presented as one such reimagining.

2. The Structural Mismatch between Learning and Schooling

Educational reform has historically focused on improving instructional practice. Curriculum alignment, pedagogical refinement, and assessment design have all been the subject of sustained attention. While these efforts have produced important gains, they have not resolved a fundamental mismatch between how learning occurs and how schooling is organized.

Research in second language acquisition has consistently demonstrated that learning is nonlinear, emergent, and highly individual Ellis [3] and Larsen-Freeman & Cameron [4] Learners progress at different rates, respond differently to similar input, and develop proficiency through complex interactions between exposure, use, and feedback. Cognitive science similarly emphasizes the role of prior knowledge, attention, and meaningful engagement in determining whether learning persists [5]

Despite this, schooling remains organized around uniform progression. Courses are sequenced, time is fixed, and learners are expected to move together. This design reflects historical priorities of efficiency and scalability rather than alignment with learning processes.

Time, in particular, functions as the dominant metric. Completion of a course becomes evidence of learning, even though time is only indirectly related to proficiency. As a result, systems often measure what is easy to quantify rather than what is most meaningful. This leads to what might be described as an epistemic substitution: time stands in for learning, and completion stands in for capability.

The consequence is a persistent tension. Educators recognize variability in theory, yet systems constrain it in practice. Learners adapt to structures that do not fully reflect their developmental trajectories, and assessment systems often capture compliance more effectively than growth.

3. Learning in a Networked World: Connectivism as Context

The rise of digital technologies has fundamentally altered the ecology of learning. Knowledge is no longer centralized; it is distributed across networks. Siemens [6] and Downes [7] have described this shift through the framework of connectivism, which positions learning as the process of forming and navigating connections within a network of information sources.

In such environments, the ability to locate, evaluate, and integrate information becomes as important as the acquisition of content itself. Learning is less about internalizing static bodies of knowledge and more about participating in dynamic systems of meaning-making.

However, while connectivism provides a useful descriptive framework, it does not by itself restructure schooling. Many educational systems continue to operate as though knowledge must be delivered sequentially and controlled through curriculum.

FILL can be understood as a structural response to this tension. Rather than treating networked learning as external to schooling, it incorporates it into the design. Learners engage with a wide range of resources—digital platforms, authentic texts, community interactions, and AI-supported tools—forming a network through which learning occurs. The role of the teacher shifts from delivering content to facilitating navigation within this network.

4. The Human Element: Meaning, Memory and Motivation

In a learning environment increasingly defined by access to information, the central challenge is no longer exposure but connection. The question is not whether learners can encounter content, but whether that content becomes meaningful enough to be retained, applied, and extended. This distinction lies at the heart of cognitive theories of learning, which consistently demonstrate that knowledge is not simply received but constructed through interaction with prior experience, purpose, and context [8].

Traditional instructional models often assume that relevance can be designed externally. Curriculum is sequenced, topics are selected, and examples are provided with the expectation that learners will find meaning within them. While such approaches can produce short-term performance, they frequently fail to generate durable learning. Information that is processed without personal significance tends to remain inert, accessible for assessment but not for application. In this sense, much of what is learned in traditional environments is, at best, temporarily held—sufficient for completion, but not integrated into the learner's cognitive framework.

Facilitated Interdependent Language Learning challenges this assumption by repositioning the learner at the center of meaning-making. Drawing on the conceptual framing articulated in *Putting Ourselves*

Back in the Equation [9], FILL environments position the learner as the source of context rather than the recipient of it. FILL environments begin not with predetermined content, but with the learner's interests, goals, and identity. Context is not imposed; it is generated. This shift has profound implications for both motivation and memory.

Consider the learner who chooses to study Korean because of an interest in K-pop. In a traditional course, exposure to Korean language and culture might include a limited set of teacher-selected themes, only loosely connected to the learner's motivation. In a FILL environment, however, the learner's interest becomes the organizing context. Vocabulary, listening tasks, reading selections, and communicative goals emerge from engagement with K-pop itself—lyrics, interviews, fan communities, and media content. The language is no longer abstract; it is embedded in a domain that already holds meaning for the learner.

Similar patterns emerge across other learners. A student interested in Minecraft seeks to communicate with players in Japan, shaping goals around interaction within that community. Another learner pursues French in order to engage more fully with Canadian hockey culture, selecting resources and communicative tasks aligned with that interest. In each case, the learner is not simply engaging with content; the learner is constructing a pathway in which language serves a purpose that is already valued.

Cognitive theory provides a clear explanation for why such approaches are effective. Learning that connects to existing schemas—structures of prior knowledge and experience—is more readily encoded and retrieved [10]. When new information is integrated into a meaningful framework, it is more likely to be retained and transferred. Conversely, information presented in isolation, without connection to prior knowledge or purpose, is less likely to persist.

Motivation research reinforces this dynamic. Deci's Self-Determination Theory [11] identifies autonomy, competence, and relatedness as key drivers of intrinsic motivation. Pink [12] extends this framework by emphasizing autonomy in time, task, team, and technique. FILL environments operationalize these principles in concrete ways. Learners determine what they study, how they approach it, the pace at which they progress, and the communities with which they engage. This alignment between design and motivation is not incidental; it is foundational.

Importantly, this does not imply that all learning must originate solely from existing interests. Rather, it suggests that meaningful engagement emerges when learners are positioned as active participants in shaping context. The role of the teacher is critical in this process. Through careful facilitation, learners are guided to expand their interests, connect them to broader domains, and develop goals that extend beyond initial motivations. What begins as an interest in music, gaming, or sport can evolve into deeper linguistic, cultural, and intellectual engagement.

The implications for memory are equally significant. Bjork's research on "desirable difficulties" suggests that learning is strengthened when learners engage in effortful processing within meaningful contexts [13]. When learners are invested in the outcome, they are more willing to persist through challenge, revise their understanding, and integrate feedback. In contrast, when tasks are externally imposed and lack personal relevance, learners are more likely to disengage or adopt surface-level strategies aimed at completion rather than understanding.

In this sense, the distinction between temporary and durable learning becomes central. Temporary learning is often sufficient to meet external expectations but does not endure. Durable learning, by contrast, becomes part of the learner's repertoire—available for use, extension, and transfer. FILL environments are designed to support the latter by ensuring that context, purpose, and motivation are not peripheral considerations but central elements of the learning process.

As learning environments continue to evolve in response to technological and societal change, the importance of meaning will only increase. Access to information can be expanded indefinitely, but without relevance, such access has limited value. By placing the learner at the center of context creation, FILL offers a model in which meaning, memory, and motivation are aligned, increasing the likelihood that learning will not only occur, but persist.

5. Facilitated Interdependent Language Learning as Structural Innovation

Facilitated Interdependent Language Learning represents a departure from course-based organization toward a proficiency-based model that aligns more closely with how learning actually develops. In FILL environments, learners pursue proficiency in languages of their choice, guided by clearly defined descriptors such as the NCSSFL-ACTFL Can-Do Statements [1]. These descriptors provide a transparent framework for goal-setting, progress monitoring, and the accumulation of evidence over time.

The role of the teacher shifts accordingly. Rather than delivering a uniform curriculum, the teacher functions as a facilitator, drawing on expertise in language acquisition, feedback, and assessment to support learners whose pathways diverge in language, pace, and focus. Curriculum becomes one resource among many. Time becomes flexible rather than fixed. Progress is measured through demonstrated ability rather than completion of prescribed units.

What distinguishes FILL from many conceptual models of personalized learning is that it has been implemented in operational settings with measurable outcomes. In work documented by Welch and Allen in *The Language Educator*, FILL classrooms have demonstrated that learners working across multiple languages within a single facilitated environment can achieve externally validated proficiency outcomes that equal or exceed those typically associated with traditional course sequences. In one such setting, learners participating in FILL achieved proficiency gains verified through the STAMP (Standards-based Measurement of Proficiency) assessment, with some students earning the equivalent of multiple years of language credit within a single academic year through demonstrated proficiency rather than seat time [14].

This distinction is critical. Because STAMP is an external, standardized assessment aligned to ACTFL proficiency levels, it provides independent validation of what learners can actually do with the language. These results suggest that when learners are given agency, supported through interdependent structures, and guided by clear proficiency targets, they are capable of achieving significant growth without reliance on traditional course sequences.

The implications extend beyond language learning. What FILL makes visible is not simply an alternative instructional approach, but a different organizing logic—one in which learning trajectories are defined by evidence of capability rather than by time spent in a system. In this sense, FILL functions not as an innovation within the existing structure, but as a prototype of a structurally different system.

6. Interdependence and the Social Dimension of Learning

A persistent misconception surrounding personalized learning is that it leads to isolation—learners working independently, often mediated primarily through technology, progressing through predetermined pathways at their own pace. This model, while efficient in certain contexts, risks reducing learning to an individual transaction between learner and content. Facilitated Interdependent Language Learning stands in direct contrast to this interpretation.

FILL is not independent learning in which students sit in front of a computer working through a prescribed sequence. It is a dynamic, socially mediated process in which learner agency is situated within a network of relationships that includes the teacher, peers, and a broader ecosystem of resources. The distinction is critical. Independence suggests separation; interdependence reflects connection.

At the center of this structure is the teacher, whose role is not diminished but fundamentally redefined. Rather than delivering content, the teacher operates as a facilitator grounded in expertise in second language acquisition theory and proficiency development. Research in SLA underscores that language development is a complex, nonlinear process shaped by meaningful input, interaction, and feedback [3]. Within a FILL environment, the teacher draws on this expertise to guide learners in setting goals at an appropriate level of proficiency, ensuring that targets are both challenging and attainable.

This guidance extends beyond goal-setting. Learners are supported in identifying and evaluating resources aligned with their objectives, whether those resources take the form of authentic texts, digital tools, community interactions, or AI-supported environments. The teacher also plays a critical role in helping learners select and refine artifacts that genuinely reflect their progress. In this sense, assessment becomes a collaborative process, grounded in shared understanding of proficiency rather than unilateral judgment.

The student-teacher relationship is therefore transformed. Authority does not disappear, but it shifts from control over content to expertise in process. The teacher becomes a partner in learning, one who observes, questions, guides, and challenges, ensuring that learners remain aligned with meaningful progress rather than superficial completion.

Equally significant is the role of peers in shaping the learning environment. The social dimension of FILL is not incidental; it is integral to its design. Learners regularly engage in discussions about their progress, sharing strategies, suggesting resources, and reflecting on challenges. These interactions create a community of practice in which learning is distributed across participants rather than centralized in the teacher.

Specific classroom practices further reinforce this interdependence. In one implementation, learners are asked to engage weekly with a current event drawn from a primary source in their chosen language. This task serves multiple purposes. It provides authentic input, connects language learning to real-world

contexts, and introduces cultural perspectives. When learners come together to discuss these events—often in a shared language such as English—they are able to examine how the same event is represented differently across linguistic and cultural contexts. This not only deepens language awareness but also fosters intercultural understanding, aligning with broader educational goals.

Shared thematic work can also anchor the learning community. For example, a class might engage with a common focus such as one of the United Nations Sustainable Development Goals. Within this shared frame, learners adapt their individual Can-Do goals to align with the broader theme, working in their respective languages while contributing to a collective inquiry. This creates a layered learning experience: individualized in execution, but communal in purpose.

What emerges from these structures is a form of social learning that is no longer mediated solely through the teacher. Instead, it becomes dynamic, distributed, and responsive. Learners interact with one another directly, drawing on diverse experiences and perspectives. The teacher remains central, but not as the sole conduit of knowledge. Rather, the teacher supports the conditions under which meaningful interaction and learning can occur.

This reconfiguration reflects broader insights from sociocultural theories of learning, which emphasize the role of interaction, collaboration, and shared activity in cognitive development. Learning, in this view, is not an individual accumulation of knowledge but a process of participation in socially mediated practices.

In a networked world, where knowledge is distributed and constantly evolving, such a model becomes not only desirable but necessary. Interdependence is not simply a pedagogical choice; it is a reflection of the conditions under which learning now takes place. FILL makes this visible by embedding interdependence into the structure of learning itself, demonstrating that personalization and community are not opposing forces, but mutually reinforcing dimensions of a coherent system.

7. Assessment as Evidence: Reframing Error, Growth, and Proficiency

Perhaps the most consequential shift in a FILL approach lies in how assessment is understood. In traditional systems, assessment frequently functions as a mechanism of judgment. Grades summarize performance, averages determine outcomes, and errors are treated as deficits to be minimized. While these practices provide a sense of order, they often obscure the developmental nature of learning and limit opportunities for growth.

A substantial body of research challenges the assumption that errors are simply indicators of failure. In second language acquisition, errors are widely understood as evidence of developmental progress, reflecting the learner's evolving internal system of language [3]. Similarly, Selinker's research on interlanguage development suggests that learners must pass through stages characterized by approximation and restructuring, during which errors are not only inevitable but necessary [15].

Cognitive science reinforces this perspective. Productive struggle—engaging with challenges that are within reach but not yet mastered—has been shown by Bjork and Bjork to strengthen learning and retention [16]. When learners are allowed to attempt, fail, receive feedback, and try again, they engage in processes that deepen understanding and support long-term memory formation. Conversely, environments that penalize error too quickly can lead learners to avoid risk, reducing opportunities for meaningful learning.

Within this context, FILL reframes assessment as the accumulation of evidence rather than the assignment of judgment. Learners collect artifacts that demonstrate what they can do across interpretive, interpersonal, and presentational modes of communication, guided by proficiency descriptors. Tools such as LinguaFolio support this process by enabling learners to set goals, reflect on their progress, and curate evidence over time [17].

External assessments, including STAMP, play a critical role by providing independent validation of proficiency. Because these assessments are not tied to a specific curriculum or pacing structure, they allow learning that emerges through diverse and individualized pathways to be recognized with credibility. This is particularly important in FILL environments, where learners are not following a uniform sequence of instruction.

An asset-based perspective underlies this approach [18]. Rather than focusing on what learners cannot yet do, assessment emphasizes what they can demonstrate and how they are progressing. Errors are reframed as data—signals that inform next steps rather than endpoints that define capability.

This shift has significant implications for learner behavior. When assessment is experienced as judgment, learners often aim to avoid mistakes and complete tasks efficiently. When it is experienced as evidence, learners become more willing to take risks, revise their work, and engage in sustained effort. The focus moves from performance to growth, from correctness to capability.

In this sense, assessment becomes not a separate phase of learning, but an integral part of it. It documents progress, informs decisions, and supports the development of proficiency in ways that more closely align with the realities of learning.

8. Artificial Intelligence as Structural Catalyst

Artificial intelligence has introduced new capabilities that challenge existing educational structures. Learners can access explanations, generate practice, and receive feedback without relying exclusively on formal instruction. These developments highlight the limitations of systems centered on content delivery.

In many contexts, responses have focused on restricting or regulating AI use. An alternative approach is to redesign learning environments so that such tools become integral to the process. In FILL environments, AI functions as one of many resources available to learners, supporting engagement rather than replacing it.

This perspective shifts the focus from tool management to system design. The question is not how to control AI, but how to create structures in which its use supports meaningful learning.

9. Emerging Developments in Higher Education

While FILL has developed primarily in secondary education, related approaches are emerging in higher education. Institutions such as the University of Washington and the University of Nebraska have contributed to the development of tools supporting learner-centered, proficiency-based approaches. Research in self-regulated learning at institutions including Michigan State University further supports the importance of goal-setting, reflection, and autonomy.

These developments remain emergent, but they indicate a growing recognition that traditional course-based structures may not fully align with contemporary learning needs. They suggest the possibility of broader systemic change.

Conclusion: Scaling Learning in a Human System

Efforts to honor human variation have often focused on adapting instruction within existing systems. Historically, scale has been achieved mechanically. Standardized curricula, synchronized pacing, and uniform assessments allow systems to manage large numbers of learners by minimizing variation. This approach produces efficiency, but it does so by constraining the very differences that characterize how individuals learn. A FILL approach suggests a different conception of scale—one that is not imposed through uniformity but emerges through the system's capacity to support variation. In such an environment, learners are not required to follow identical paths in order for the system to function. Instead, diverse trajectories are expected, supported, and connected through shared structures of proficiency, facilitation, and evidence. Scale, in this sense, is not achieved by reducing difference, but by designing for it. What appears complex at the level of the individual becomes coherent at the level of the system, not because it has been standardized, but because it has been intentionally structured to accommodate the full range of human learning.

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Implementing Discussion-Based Pedagogy in the EFL Classroom: Frameworks, Practices, and Emerging Challenges

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Abstract

This paper synthesizes recent research on discussion-based pedagogy in English as a Foreign Language (EFL) classrooms, with particular attention to the period from 2016 to 2025. It examines how discussion-based learning supports communicative competence, critical thinking, motivation, and intercultural awareness, and it considers the classroom conditions that enable or constrain these outcomes. The review is informed by key perspectives in language education, including Communicative Language Teaching, Sociocultural Theory, Translanguaging Pedagogy, and Interactional Competence Theory, all of which frame classroom discussion as a socially situated process of meaning-making. Across the literature, five major discussion types emerge: critical and analytical discussions, translanguaging-based discussions, drama and role-play discussions, task-based and problem-solving discussions, and global or online discussions. The review also shows that technology has widened the scope of discussion through blended learning, online platforms, and AI-mediated interaction. These innovations can extend participation, provide feedback, and support multilingual communication, but their pedagogical value depends on teacher mediation and digital literacy. At the same time, the literature identifies persistent challenges, including unequal participation, tension between fluency and accuracy, limited teacher preparation, assessment constraints, and the influence of exam-oriented or teacher-centered educational cultures. The paper concludes that discussion-based pedagogy remains one of the most effective and adaptable approaches in EFL education, provided that it is scaffolded carefully, aligned with curriculum and assessment, and supported by institutional and technological resources.

Keywords: *discussion-based pedagogy, EFL, communicative competence, translanguaging, online discussion*

1. Introduction

The rise of communicative and learner-centered paradigms has significantly reshaped English as a Foreign Language (EFL) education. Within this shift, classroom discussion has emerged as a central pedagogical practice for promoting authentic interaction, critical engagement, and collaborative meaning-making. Rather than treating language as a set of isolated forms, discussion-based pedagogy positions it as a social resource through which learners express ideas, negotiate understanding, and participate in meaningful exchange [1], [2].

This orientation reflects broader developments in contemporary language teaching, particularly the emphasis on communicative competence, task-based learning, and intercultural communication. Through discussion, learners apply linguistic knowledge in purposeful contexts, bridge form and meaning, and build confidence in using English as a medium of interaction. At the same time, discussion supports wider educational aims by encouraging perspective-taking, reasoning, and learner agency [3], [4].

Despite these advantages, discussion-based pedagogy is not always easy to implement. In many EFL settings, teachers work within exam-oriented systems, large classes, or instructional traditions that still favor teacher-fronted delivery and accuracy-based assessment. As a result, discussions may be constrained by limited teacher preparation, unequal participation, and insufficient institutional support [5]. This paper examines discussion-based pedagogy as both a promising and a complex approach to EFL teaching.

2. Literature Review

Research consistently demonstrates that discussion-based pedagogy is highly effective in EFL education, particularly for developing communicative competence, motivation, and intercultural awareness. Across diverse contexts, structured discussions improve both linguistic accuracy and

communicative fluency by engaging learners in purposeful interaction [6], [7]. These findings are supported by key perspectives in language education: Communicative Language Teaching positions discussion as authentic language use; Sociocultural Theory explains learning through interaction, mediation, and scaffolding; Translanguaging Pedagogy highlights the role of learners' full linguistic repertoires; and Interactional Competence Theory emphasizes the conversational skills developed through participation [1], [2], [8], [9].

2.1 Discussion and Communicative Competence

A substantial body of research identifies discussion as central to communicative competence. By requiring learners to express opinions, negotiate meaning, and respond spontaneously, discussions promote language use that is functional, contextualized, and socially meaningful. Al Zahrani and Elyas found that structured discussion tasks improved discourse organization and the ability to articulate opinions, while Park showed that discussions based on authentic news texts enhanced vocabulary development, sociocultural understanding, and critical engagement [6], [10]

From a sociocultural perspective, discussion creates opportunities for learners to build knowledge collaboratively through feedback, mediation, and scaffolding within interaction [8]. Meta-analytic evidence likewise confirms that oral interaction remains one of the most effective means of fostering communicative competence, especially when discussions are guided by meaningful prompts and clear communicative goals [7]. Task-based discussions are especially effective because they embed language in problem-solving and shared goals, leading to gains in fluency, accuracy, and learner engagement [11].

2.2 Technology, Multimodality, and AI-Mediated Discussion

Recent studies show that technology has significantly expanded the scope of discussion-based pedagogy. In blended and flipped learning environments, learners can engage with materials before class and use classroom time for deeper interaction, reflection, and feedback [12]. Online and blended discussion platforms enhance learner autonomy and communicative depth, while digital discussion boards promote reflection and peer collaboration [13], [14]

These developments also reinforce the multimodal nature of contemporary EFL communication, where interaction increasingly combines spoken language, writing, visuals, and digital tools. Within this context, AI has emerged as a major development. AI tools, including ChatGPT, can support reflective discussion, provide reformulations and prompts, and facilitate translanguaging through translation and adaptive feedback [15], [16]. Such tools may lower anxiety, increase confidence, and widen participation, especially when their use is carefully mediated by teachers.

2.3 Teacher Readiness and Digital Literacy

The effectiveness of discussion-based pedagogy depends heavily on teacher readiness. As discussions become more technologically mediated, teachers must combine digital competence with sound pedagogical judgment. This includes designing meaningful discussion tasks, maintaining communicative authenticity, and ensuring that participation remains equitable [3], [17]. Without deliberate facilitation, discussion spaces–especially online ones–can reproduce unequal participation patterns, with more confident or proficient learners dominating exchanges [18].

From this perspective, the teacher's role is less that of information provider and more that of mediator, organizer, and interactional guide. Teachers need to scaffold discussion, manage turn-taking, support quieter learners, and assess communicative performance in ways that value interaction as well as accuracy. They must also foster critical digital literacy so that learners can participate responsibly and effectively in digital and intercultural communication [8], [19].

2.4 Motivation, Inclusion, and Intercultural Growth

Beyond linguistic gains, discussion-based pedagogy has a strong affective dimension. Research indicates that discussions can reduce foreign language anxiety and increase willingness to communicate by creating supportive, collaborative environments in which learners can test ideas without excessive fear of correction [20]. Small-group interaction is particularly helpful in this regard, as it lowers performance pressure and encourages peer support.

This motivational value is reinforced when learners are given space to express personal views and draw, when necessary, on familiar linguistic resources. Translanguaging-informed discussion practices can enhance both inclusion and confidence, particularly for learners with lower proficiency [21], [16]. Discussion-based pedagogy also contributes significantly to intercultural communicative competence. Discussions centered on cultural themes and global issues foster intercultural sensitivity, empathy, and critical cultural awareness [22], [23]. Cross-border online discussions, in particular, improve communicative flexibility and global perspective [24].

3. Findings: Types and Implementation of Discussions

The literature identifies five major forms of discussion-based pedagogy in EFL classrooms: critical and analytical discussions, translanguaging-based discussions, drama and role-play discussions, task-based and problem-solving discussions, and global or online discussions. Although each type emphasizes different learning goals, all are grounded in interaction, learner agency, and collaborative meaning-making.

3.1 Critical and Analytical Discussions

In classroom practice, these discussions are most effective when they are carefully staged rather than introduced as free debate from the outset. Pre-discussion reading, question prompts, and role allocation help learners move from comprehension to analysis and finally to position-taking. This structure is especially important in EFL settings where students may have ideas to share but lack the discourse markers, rhetorical language, or confidence needed to sustain argument in English. When teachers model useful phrases for agreeing, disagreeing, qualifying claims, and citing evidence, learners are better able to participate in academically oriented discussion without losing spontaneity.

Critical discussion also supports disciplinary literacy by familiarizing learners with the language of reasoning, comparison, and evaluation. In this sense, its value extends beyond speaking practice. Students learn how to formulate defensible positions, respond to challenges, and organize ideas coherently for an audience. These abilities are central not only to oral communication but also to academic writing and presentation tasks, making critical discussion a particularly productive bridge between language learning and broader educational outcomes [6], [10].

Critical and analytical discussions include debates, Socratic seminars, and thematic discussions that require learners to justify opinions, evaluate ideas, and respond to alternative perspectives. These formats are especially effective for developing higher-order thinking alongside linguistic competence [6], [10]. They move learners beyond comprehension toward interpretation and argumentation, supporting participation in academic and intercultural discourse communities.

3.2 Translanguaging-Based Discussions

A further strength of translanguaging-based discussion is that it can be strategically controlled rather than left entirely open. Teachers may, for example, allow learners to brainstorm in the first language, compare concepts bilingually, and then report or summarize in English. Such sequencing preserves English as the target language while recognizing that multilingual learners often think through complex ideas more effectively when they can move across languages. This is particularly valuable in mixed-ability classrooms, where selective translanguaging can narrow participation gaps and help less proficient students remain cognitively engaged.

The literature also suggests that translanguaging changes the classroom climate by legitimizing learners' identities and reducing the stigma attached to partial or hesitant English production. Rather than interpreting first-language use as failure, this approach treats it as a temporary mediational resource that supports fuller participation in discussion. In digital settings, this process can be amplified through captions, translation features, and bilingual AI prompts, which make multilingual interaction more manageable and inclusive [16], [21].

Translanguaging-based discussions allow learners to draw on both English and their first language(s) to clarify meaning, build ideas, and sustain participation. In multilingual EFL classrooms, this practice has been shown to increase inclusion, reduce anxiety, and support conceptual understanding, especially for learners with lower proficiency [21], [16]. Digital and AI-supported environments can strengthen such practices by providing translation, reformulation, and multilingual feedback.

3.3 Drama and Role-Play Discussions

Another advantage of drama-based discussion is that it helps learners rehearse language for socially complex situations that are difficult to practice through ordinary classroom conversation. Simulated service encounters, job interviews, negotiations, or conflict-resolution scenarios require students to interpret roles, manage politeness, and adjust register in real time. Because meaning is carried not only by words but also by gesture, tone, and stance, these activities strengthen pragmatic and sociolinguistic awareness in ways that conventional question-and-answer exchanges often do not.

Drama-based formats also create space for reflection after performance. Post-task debriefing allows learners to analyze what expressions were effective, where misunderstandings occurred, and how different linguistic choices shaped the interaction. This reflective stage is important because it turns performance into explicit learning, linking creative participation with clearer awareness of discourse conventions and interactional choices [25].

Drama and role-play discussions introduce an embodied and performative dimension to language learning. By simulating interviews, negotiations, storytelling, or everyday social encounters, these activities allow learners to practice language in realistic and emotionally engaging contexts. They are especially useful for developing pragmatic awareness, pronunciation, and sociolinguistic sensitivity [25].

3.4 Task-Based and Problem-Solving Discussions

Task-based discussion is particularly valuable in contexts where English exposure outside the classroom is limited. Because learners are required to reach an outcome together, they have repeated reasons to ask follow-up questions, clarify intention, and reformulate ideas. These features generate rich opportunities for negotiation of meaning, which has long been regarded as one of the central mechanisms of second-language development. The collaborative nature of task completion also helps shift attention away from fear of error and toward shared accomplishment.

Not all tasks, however, generate equally rich discussion. Research indicates that open problems, decision-making tasks, and information-gap activities are generally more productive than highly predictable exercises because they require genuine exchange and multiple possible responses. The pedagogical implication is that teachers must design tasks with communicative pressure and intellectual engagement in mind; otherwise, discussion may become procedural rather than exploratory [7], [11], [13].

Task-based and problem-solving discussions are among the most strongly supported forms of discussion in literature. In these activities, learners use language to solve a problem, make a decision, or plan a project. Their effectiveness lies in the fact that language is used as a tool for achieving shared outcomes rather than as an end in itself, creating conditions for negotiation of meaning, peer feedback, and collaborative reasoning [11], [13].

3.5 Global and Online Discussions

The educational significance of global and online discussions lies not only in the expansion of interactional space but also in the diversification of audiences. When learners speak or write to peers from other institutions or countries, English becomes a real medium of exchange rather than a classroom display language. This shift often increases investment and attentiveness because students recognize that successful communication now depends on clarity, responsiveness, and intercultural sensitivity, not simply on meeting a teacher's expectations.

At the same time, online discussion introduces new demands. Learners must manage delayed responses, multimodal cues, and platform-specific conventions such as chat etiquette, camera use, or threaded replies. These demands can be pedagogically valuable because they develop digital communication skills alongside language competence. When thoughtfully moderated, online discussion therefore extends the scope of EFL pedagogy to include not only spoken fluency but also online presence, multimodal expression, and responsible participation in networked communication [15], [22], [24].

Across these five formats, a common principle emerges: discussion-based pedagogy works best when interaction is purposeful, inclusive, and matched to learner needs. Some formats privilege reasoning, others support multilingual mediation or creative role-taking, and still others foreground collaboration or intercultural exchange. Yet all require learners to listen, respond, adapt, and co-construct meaning, which explains why discussion remains one of the most productive vehicles for communicative development in EFL classrooms.

Global and online discussions represent the most recent expansion of discussion-based pedagogy. Through videoconferencing, online forums, and international collaboration projects, EFL learners can interact with peers across cultures and contexts. These formats develop intercultural awareness as well as digital and multimodal literacy, since learners often combine written, spoken, and visual communication across platforms [24], [22]. AI tools further extend these possibilities by supporting multilingual interaction, automated feedback, and individualized prompts [15], [16].

4. Discussion: Advantages and Challenges

Discussion-based pedagogy offers a comprehensive framework for developing linguistic, cognitive, affective, and intercultural competencies in EFL education. By positioning language as a tool for interaction and meaning-making, it transforms the classroom into a space of collaborative inquiry.

4.1 Benefits

Another important benefit is that discussion enables learners to integrate multiple dimensions of language performance at the same time. In a single discussion task, students may need to retrieve vocabulary, monitor grammar, interpret a peer's intention, choose an appropriate stance, and react within time pressure. This integration mirrors real communication far more closely than decontextualized exercises. For that reason, discussion often provides stronger evidence of usable proficiency than activities that isolate one language component at a time.

Discussion also supports the development of learner agency. Because students must make choices about what to say, how strongly to say it, and how to respond to others, they are positioned as active contributors rather than recipients of content. Over time, this can reshape classroom dynamics by making participation more dialogic and less dependent on teacher initiation. Such a shift is particularly valuable in EFL environments where opportunities for extended learner talk are otherwise limited.

From a longer-term perspective, the benefits of discussion-based pedagogy may be cumulative. Repeated exposure to structured discussion can build habits of listening carefully, formulating ideas under pressure, and tolerating ambiguity during communication. These are not only linguistic skills but also transferable academic and professional competencies. As a result, discussion-based learning contributes to the wider educational aim of preparing learners to participate effectively in collaborative and multilingual environments [7], [8], [9].

From a linguistic perspective, discussion-based learning promotes fluency, lexical development, and pragmatic competence. Unlike teacher-centered instruction, it requires learners to produce extended discourse, respond spontaneously, and adapt language to context and audience [13], [9]. Cognitively, it supports critical thinking and metacognitive awareness by encouraging learners to evaluate information, construct arguments, and reflect on different perspectives.

Discussion also has important affective and social benefits. It reduces foreign language anxiety, increases willingness to communicate, and fosters a sense of community through collaboration and peer support [20]. In addition, by engaging learners with cultural topics and global issues, it strengthens intercultural communicative competence and prepares students for more diverse communicative contexts [22], [23].

4.2 Persistent Challenges

A further challenge concerns the quality of discussion prompts and task framing. Even when teachers allocate time for discussion, interaction can remain superficial if questions invite only short, predictable answers or if students do not have sufficient conceptual preparation. Effective discussion depends on tasks that are cognitively engaging, linguistically accessible, and open enough to sustain multiple viewpoints. In practice, designing such tasks can be demanding, particularly when teachers work with rigid textbooks or limited planning time.

Assessment poses an additional difficulty because discussion performance is dynamic and distributed across participants. It is often easier to evaluate an individual written product than to capture the quality of contribution, responsiveness, and collaboration in a live discussion. Without clear rubrics, assessment may appear subjective, which can discourage teachers from integrating discussion regularly. Yet if discussion is not assessed at all, students may interpret it as peripheral rather than central to learning.

There are also challenges related to learner beliefs. Some students may equate good language learning with correction, memorization, and teacher explanation, and may therefore view discussion as less serious or less efficient. Others may avoid speaking because they associate public language use with

loss of face or exposure of weakness. For discussion-based pedagogy to succeed, teachers often need to address these beliefs explicitly, showing students how interaction contributes to learning and why partial, developing language can still be pedagogically valuable [5], [18], [20].
Despite these advantages, several challenges complicate implementation. Teachers often struggle to balance fluency and accuracy when providing feedback. Unequal participation is another common problem, as more confident or proficient learners may dominate discussions while others remain passive [18]. Teacher preparedness also remains a key issue, since effective facilitation requires expertise in scaffolding, interaction management, and digital pedagogy [17], [19].
Institutional constraints such as large classes, rigid curricula, and exam-oriented systems often leave limited space for open-ended discussion [7]. Cultural factors may also influence participation, especially where learners are accustomed to teacher-centered instruction and hesitate to express opinions or challenge others. These conditions make discussion-based pedagogy highly effective, but also strongly context-dependent.

5. Pedagogical Implications

The literature points to several important implications for EFL teaching. First, discussion must be scaffolded through pre-discussion support, role assignment, and gradual progression from controlled interaction to more open-ended exchange. Second, teacher development is essential. Teachers need preparation not only in language instruction, but also in facilitation, digital pedagogy, and assessment of interaction. Finally, institutions must provide supportive conditions, including reasonable class sizes, flexible classroom layouts, and assessment practices that recognize communicative performance.
These implications suggest that discussion-based pedagogy should be planned as a coherent instructional approach rather than treated as an occasional speaking activity. When discussion is added only at the end of a lesson, without preparation, follow-up, or assessment, its impact is often limited. By contrast, when it is integrated into lesson objectives, materials, and classroom routines, learners begin to understand that discussion is a central route to language development rather than a supplementary exercise.
Scaffolding is especially important at the level of discourse. Many learners know relevant vocabulary or grammar but struggle to enter a conversation, extend a turn, or disagree politely. For this reason, discussion instruction should include discourse frames, model exchanges, and explicit attention to interactional moves such as inviting a partner in, asking for clarification, or building on a previous point. These supports help transform passive linguistic knowledge into usable communicative behavior.
Teachers may also need to scaffold content knowledge. Discussions are rarely productive when learners have little to say about the topic. Short readings, visuals, case studies, or advance questions can provide the conceptual foundation needed for richer interaction. In this sense, effective scaffolding supports both language and ideas, ensuring that students are prepared to participate meaningfully rather than merely speak for the sake of speaking.
Teacher development should therefore include opportunities to observe, analyze, and rehearse discussion facilitation. Watching recordings of classroom interaction, examining transcripts, or engaging in peer observation can help teachers notice patterns that are otherwise easy to miss, such as unequal turn distribution, over-scaffolding, or missed opportunities for follow-up questioning. This kind of professional reflection is particularly useful because discussion quality often depends on subtle interactional decisions made in real time.
Facilitation also involves knowing when not to intervene. Teachers who dominate the interaction, answer too quickly, or correct every error may unintentionally reduce learner initiative. Professional development should therefore help teachers distinguish between supportive mediation and excessive control, so that discussions remain both structured and genuinely learner-centered.
In digitally mediated discussion, pedagogy must also account for access and usability. Teachers need contingency plans for uneven connectivity, different device types, and varying levels of student familiarity with online platforms. Seemingly technical issues can quickly become participation issues if some learners cannot follow the discussion smoothly or are unsure how to contribute in a particular format. Digital literacy, therefore, is inseparable from inclusion.
AI literacy should likewise include ethical and critical dimensions. Learners and teachers need guidance on when AI support is helpful, how to verify AI-generated language, and how to avoid over-reliance on automated responses that reduce authentic interaction. Used well, AI can expand practice and feedback; used uncritically, it can narrow learner agency by substituting generated language for genuine communicative effort.

Curriculum reform also requires progression. Discussion expectations should develop across levels, beginning with simple turn-taking and opinion sharing and moving toward argumentation, collaborative problem-solving, and intercultural dialogue. A sequenced curriculum makes it easier for teachers to align topics, tasks, and assessment with realistic developmental goals rather than treating discussion as a generic ability that should emerge automatically.

Similarly, assessment should balance individual accountability with recognition of discussion as co-constructed performance. Rubrics can include dimensions such as relevance, clarity, responsiveness, support for others' contributions, and strategic language use. When learners understand these criteria, they are more likely to approach discussion as a serious academic practice and not merely as informal conversation.

Institutional support also includes symbolic recognition. When school policies, timetables, and evaluation systems prioritize communicative outcomes, teachers are more likely to invest in discussion-rich pedagogy. Conversely, when oral interaction is absent from program goals or assessment frameworks, even motivated teachers may struggle to justify the time discussion requires. Sustainable implementation therefore depends on alignment between classroom practice and institutional expectations.

The literature points to several important implications for EFL teaching. First, discussion must be scaffolded through pre-discussion vocabulary work, guiding questions, role assignments, and sentence stems. Pair work and guided small-group tasks can prepare learners for more open-ended formats such as debates or intercultural discussions [8].

Second, teacher development is essential. Teachers need preparation not only in language instruction, but also in facilitation, assessment, digital literacy, and ethical AI use. Third, curricula and assessment practices should better reflect the value of oral interaction by including objectives and rubrics related to turn-taking, argumentation, negotiation of meaning, and intercultural responsiveness [7], [19].

Finally, institutions must provide supportive conditions, including reasonable class sizes, flexible classroom layouts, access to technology, and time for professional development. When these conditions are in place, discussion can function not simply as an activity but as a central mode of language learning.

6. Conclusion

Discussion-based pedagogy is one of the most significant developments in contemporary EFL education because it treats language as a tool for interaction, inquiry, and collaboration. Across the literature, it emerges as a powerful means of developing communicative competence, critical thinking, motivation, and intercultural awareness.

Its effectiveness is supported by complementary theoretical perspectives and by a wide range of classroom practices, from critical discussion and translanguaging to task-based, drama-based, and global online interaction. At the same time, its success depends on careful scaffolding, informed facilitation, technological awareness, and institutional support.

Looking ahead, digital and AI-mediated discussion is likely to play an increasingly important role in EFL education. These developments offer new opportunities for feedback, multilingual support, and cross-cultural interaction, but they should be used to extend human dialogue rather than replace it. In this sense, discussion-based pedagogy is not simply a teaching technique; it is a pedagogical orientation that places communication, participation, and shared inquiry at the center of language education.

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University Teachers' Challenges and Expectations in Bi/Multilingual Disciplinary Literacy Instruction: A Qualitative Cross-disciplinary Study

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Abstract

In today's linguistically diverse higher education contexts, teaching bi/multilingual disciplinary literacies (BMDLs) becomes more challenging when both teachers and students are non-native speakers of the language of instruction. This leads to university teachers' increased expectations for students' secondary education in disciplinary literacy (DL) development. Considerable BMDL studies [e.g. 1, 2] have focused on secondary education, yet challenges and demands in higher education settings remain significantly under-researched. This study explored university teachers' perspectives on the challenges they and their students face regarding BMDL practices. It also investigated teachers' expectations of both their students and the students' secondary education regarding BMDL development. The data were collected through semi-structured interviews conducted across countries, disciplines, and languages of instruction, and were analysed both inductively and deductively. The participants were 41 university teachers from Türkiye (n=10), Albania (n=13), the Czech Republic (n=10) and Kuwait (n=8), who taught natural (12) and social sciences (29) in a language other than their first language. The languages of instruction were English, German and Arabic. While most participants encountered challenges adapting pedagogical strategies to meet their students' needs for BMDL development, some reported difficulties stemming from teaching in a foreign language. Perceived student difficulties involved aspects of DL comprehension, learning, and application, and these reported difficulties differed across disciplines. Findings demonstrated that expectations from secondary education reflected the challenges the participants experienced; however, they varied across disciplines, mostly centring on basic discipline-specific knowledge and skills, familiarity with concepts and analytical skills, and students' equipment with the necessary language skills. By identifying challenges university teachers face in bi/multilingual classrooms and shedding light on their expectations, this study contributes to a better understanding of current issues in BMDL instruction and offers valuable insights for future pedagogical practices and policy development in both secondary and higher education.

Keywords: *bi- and multilingual disciplinary literacies, disciplinary literacies, foreign language instruction, teachers' expectations, teachers' challenges, tertiary education*

1. Introduction

The internationalisation of higher education has brought a widespread shift toward using second or foreign languages as media of instruction. In these contexts, both instructors and students must engage with complex academic content through a language that is not their first, foregrounding the importance of disciplinary literacies (DL), the capacity to think, communicate, and construct knowledge in discipline-specific ways [3, 4]. When DL must be developed across two or more languages, the concept extends to bi/multilingual disciplinary literacies (BMDLs), an integrated competence that involves the coordination of language, content, cognition, and semiotic resources [5].

Despite the scale of this shift, empirical research on BMDLs in higher education remains limited. Existing work has focused on secondary education [1], challenges in general English-medium instruction (EMI) [6], or students' perspectives [2]. What looks largely absent in the related literature is a systematic examination of how university teachers experience BMDL challenges, particularly in relation to students' secondary education preparation. This study addresses this gap by investigating: (a) teachers' challenges in BMDL instruction, (b) their perceptions of student difficulties, and (c) their expectations regarding student preparedness and the role of secondary education. Drawing on interviews with 41 university teachers from four countries, across natural and social sciences taught through three different languages (i.e., English, German, Arabic), the study offers a cross-contextual account of how BMDLs are experienced in contemporary higher education.

2. Literature Review

2.1 Challenges in BMDL Instruction

DL encompasses discipline-specific vocabulary, epistemological orientations, and modes of reasoning that go beyond general language proficiency [13]. In multilingual settings, this extends to BMDLs, navigating disciplinary meaning-making across multiple languages and semiotic resources. Dafouz and Smit's [2] ROAD-MAPPING framework illustrates how language, content, and institutional context interact in internationalised universities, and positions BMDLs as an integrated competence rather than an additive extension of language skills.

Empirical research in EMI contexts shows that teachers and students struggle to negotiate complex disciplinary meanings in a foreign language, limiting students` participation and knowledge construction [6]. Crucially, these difficulties are not reducible to language proficiency alone. Soruç et al. [6] demonstrate that language-related challenges are shaped by the interaction between English proficiency and disciplinary knowledge, while Kamaşak and Sahan [7] show that academic success reflects a combination of language proficiency, L2 attitudes, and prior disciplinary preparation. Students' struggles often reflect unfamiliarity with discipline-specific practices such as constructing arguments, interpreting evidence, and communicating in ways valued by academic communities rather than linguistic deficiency alone. Despite this growing understanding, comparatively few studies examine how university teachers navigate the interplay between disciplinary knowledge, language, and cognition, the perspective this study foregrounds.

2.2 The Secondary-Tertiary Transition and Teacher Expectations

The secondary-tertiary transition is a critical juncture at which mismatches between expectations and preparedness become apparent. Students frequently enter university with limited disciplinary thinking, insufficient academic literacy, and underdeveloped critical abilities [7]. EMI research sharpens this picture: Aizawa and Rose [8] found that limited secondary-level English exposure significantly hampered university EMI transitions, and Rose et al.'s [9] systematic review confirmed that students from L1-medium secondary schools face greater challenges, particularly in academic writing.

McKinley [10] argues that higher education preparedness must encompass disciplinary knowledge, academic socialisation, and critical engagement, rather than merely language proficiency. Wollscheid et al. [11] provide complementary evidence by showing that both staff and students perceive academic literacy demands as discipline-specific and multidimensional. Consequently, university teachers often find themselves addressing foundational gaps such as vocabulary, concept review, and analytical skills that they expect from secondary education [12]. The underlying argument emerging from this literature is that BMDLs development should be understood as a continuous trajectory rather than a stage-specific outcome. By foregrounding teachers' perspectives on the relationship between instructional challenges and students' prior preparation, this study connects BMDL challenges to broader educational trajectories across multiple countries and disciplines.

3. Methodology

3.1 Research Aims and Objectives

The study investigated the challenges tertiary teachers report in teaching BMDLs, as well as their expectations of their students and of secondary education regarding BMDLs. As the scope of this paper does not allow for a deeper cross-disciplinary analysis and exploration of differences among disciplines,

the findings are presented for two broad disciplinary domains: the social and natural sciences. Two research questions were formulated to address the aim:
RQ1: What challenges do tertiary teachers report in teaching BMDLs?
RQ2: What are tertiary teachers' expectations of their students and their secondary education regarding BMDLs development?

3.2 Sample and Data Collection Method

The selection of countries and participants was guided by a combined purposive–convenience sampling strategy. Our qualitative study employed in-depth semi-structured interviews with university teachers (n = 41) with varying length of teaching experience representing social (n = 29) and natural (n = 12) sciences, four countries – the Czech Republic (n = 10), Turkey (n = 10), Kuwait (n = 8), and Albania (n = 13), and diverse institutional settings and linguistic backgrounds (see Table 1) following a survey instrument and interviewer guidelines designed and piloted within COST Action CA21114. Ethical approval for the study was obtained from the Institutional Review Board of Boğaziçi University (ID no: 2025-27), and the ethical guidelines of the participating universities were thereafter followed. The teachers' languages of instruction were English (n = 38), German (n = 1) and Arabic (n = 2). The interviews were conducted online and in person over three months, from November 2024 to January 2025, and were recorded with participants' consent. Each participating teacher was assigned a code in this study (such as T4 or T11). The codes are used in the Findings section to cite interview extracts that illustrate the findings.

Table 1. Research Participants

Data holder (country_initials)	Code	Field	Language of instruction	Length of teaching experience in years	Programme level	Percentage of courses taught in a FL in %	Length of interview in minutes
Coder 1 (CZ_JZ)	T1	Literature	English	10–15	BA/MA	100	51
	T2	Literature	English	10–15	BA/MA	100	41
	T3	Literature	English	15+	BA/MA	100	44
	T4	Geography	English	10–15	BA/MA	0–25	31
	T5	Literature	German	5–10	BA/MA	51–75	43
	T6	History	English	10–15	BA/MA	0–25	44
	T7	Literature	English	10–15	BA/MA	100	33
	T8	Literature	English	15+	BA/MA	100	65
	T9	Geography	English	15+	BA/MA/PHD	0–25	50
	T10	Literature	English	15+	BA	100	43
Coder 2 (TR_SKD)	T11	Biomedical Engineering	English	1–5	BA	100	36
	T12	Physics	English	5–10	BA/MA/PHD	100	50
	T13	Chemical and Metallurgical Engineering	English	15	BA/MA/PHD	100	44
	T14	Psychological Counselling	English	5–10	BA	25	37
	T15	Environmental Engineering	English	5	BA/MA/PHD	100	35
Coder 3 (TR_ÖÇA)	T16	Sociology	German, English	1–5	BA/BSC	75	31
	T17	Biology	English	15+	BA/BSC/MSC	25	28
	T18	Economics	English	5–10	BA/BSC	25	30
	T19	International Trading	English	1–5	BA/BSC/MSC	76–100	32
	T20	Marketing	English	1–5	BA/BSC	25	28
Coder 4 (KW_ZBI)	T21	Business	English	10–15	BA/BSC	100	41
	T22	Business	English	1–5	BA/BSC	100	46
	T23	Education	English	15+	BA/BSC	100	40
	T24	Architecture and Design	English	1–5	BA/BSC	100	31
	T25	Business	English	1–5	BA/BSC	100	46

	T26	Architecture and Design	English	1–5	BA/BSC	100	32
	T27	Business	English	5–10	BA/BSC	100	37
	T28	Arts Sciences	English	15+	BA/BSC	100	31
Coder 5 (AL_ES)	T29	Linguistics	English	1–5	BA	100	37
	T30	Management	English	15+	BA/MSC	75	29
	T31	Computer Science	English	1–5	BSC	100	32
	T32	Psychology	English	1–5	BA/BSC	100	31
	T33	Economy	English	5–10	BA	100	39
	T34	Oral medicine	English	1–5	BSC/MSC	100	30
	T35	Dentistry	English	1–5	BSC/MSC	100	33
	T36	Medicine	English	1–5	BSC	100	30
	T37	Computer Science	English	1–5	BSC	76–100	31
	T38	Psychology	English	10–15	BA/MSC	76–100	30
	T39	Psychology	English	10–15	BA/MSC	51–76	33
	T40	Theology	English, Arabic	1–5	BA	100	29
	T41	Theology	English, Arabic	1–5	BA	100	32

3.3 Data Processing and Analysis

The recordings were transcribed with the help of AI tools, proofread for accuracy and analysed using thematic analysis [13]. The data coding process involved all six stages [13] and employed both deductive and inductive approaches. An initial version of a coding manual was drafted using the deductive approach, with additional codes added through inductive coding and expert discussions. As the manual included high-inference categories, validation was conducted by five coders, each of whom independently coded one full interview. The acceptable level of inter-coder reliability was set at 80% agreement, and this was achieved across all coders in two rounds of coding. The main issue that needed to be addressed during this process was the density of codes, which was lower with two of the coders but was resolved via expert discussions, after which the codes were refined, and all of the interviews were coded using NVivo qualitative data analysis software (compatible versions 14 and 15). The final coding manual included detailed examples of the research participants' utterances for each of the codes and comprised 56 A4 pages divided into two sections: (1) DL, and (2) language aspects of DL. This paper focuses on the interpretation of data collected across both sections, specifically on teachers' and students' challenges in teaching DL, the language aspects of DL, and their expectations of their students and their secondary education in both areas (see Table 2).

Table 2. Themes and Codes

Themes	**Codes**
Teachers' challenges	Challenges in teaching disciplines Challenges in teaching in a foreign language Challenges in teaching critical thinking Challenges in cultural perspectives
Perceived students' challenges	Comprehension of disciplinary literacies Learning and applying DL
Teachers' expectations of students	Coherence in writing/speaking Ability to read in a foreign language Understanding and speaking in a foreign language Knowing how to use technological tools Variety/diversity among students Analytical thinking skills Familiarity with concepts Basic disciplinary knowledge and skills Academic writing skills Awareness and basic knowledge of the field

Teachers' expectations of the students' secondary education teachers	Promoting (critical) thinking Teaching discipline-specific knowledge and practising Encouraging students to read Promoting interdisciplinary group work Teaching soft skills Promoting argumentation Designing student-oriented tasks Teaching learning strategies Curricular demands alignment Cooperation among teachers from various disciplines

4. Findings

The analysis revealed four themes: teachers' own challenges, perceived student challenges, expectations of students, and expectations of secondary education teachers. These themes demonstrate that classroom difficulties are shaped by both students' pre-university preparation and systemic factors in secondary education.

4.1 Teachers' Challenges

Teachers reported difficulties that centre on teaching subject content in a foreign language and promoting critical thinking. Many struggled to explain disciplinary terminology, attributing this to the abstract nature of the concepts or to their own unfamiliarity with the terms in the language of instruction. Others emphasised challenges arising from students' language proficiency, leading to insufficient content comprehension and limited classroom engagement. A Kuwaiti business teacher illustrated the dual burden: "You're doing dictionary work, as well as teaching the concepts – the students have to first understand what the key concepts mean in English, before they understand the application" (T27).
Additional challenges included institutional and curricular constraints, particularly limited resources and textbooks and student diversity in disciplinary backgrounds, learning experiences, and cultural orientations. Natural science teachers more frequently emphasised gaps in terminology and procedural knowledge, while social science teachers highlighted difficulties with argumentation and critical engagement.

4.2 Perceived Student Challenges

Teachers noted that students faced difficulties with comprehension, acquisition, and application of DL. Many students struggled to understand complex discipline-specific texts, limiting their ability to deepen disciplinary knowledge and participate in classroom discussions. Teachers attributed these challenges to limited language proficiency, weak academic language skills, and short attention spans. Students also lacked analytical, argumentative, and critical thinking skills needed for meaningful disciplinary engagement.
Notably, even students with reasonable disciplinary knowledge often could not transfer it to practical tasks. A Czech geography teacher explained: "Geography is a practical discipline, and that's the biggest challenge for them to apply the knowledge and skills in real life. We really teach practical things… It's about understanding, not about learning facts" (T4). Teachers attributed these difficulties to insufficient secondary education preparation and gaps in prior knowledge, and reported spending additional class time that might facilitate comprehension and skill application.

4.3 Expectations of Students

Teachers expressed clear expectations regarding students' secondary school preparation across three dimensions. First, students should possess foundational disciplinary knowledge, such as familiarity with discipline-specific concepts and the ability to use relevant technological tools. Second, they should bring adequate academic skills and language proficiency, as well as the ability to understand academic discourse and communicate effectively in oral and written forms. Third, students should have well-developed cognitive and higher-order thinking skills. As a Turkish biomedical engineering teacher stated: "My main expectation is an analytical thinking structure – to be able to take an idea and synthesise it and produce new ideas… when that analytical intelligence is not formed, the thing cannot be formed successfully" (T11). Despite these expectations, teachers consistently reported that many

students failed to meet these criteria upon university entry, resulting in a mismatch that affects both teaching and learning.

4.4 Expectations of Secondary Education

Participants articulated expectations for secondary education teachers' roles in university preparation. They stressed the importance of developing discipline-specific knowledge and terminology, promoting critical and analytical thinking, and building learning and study skills alongside soft skills. Teachers also highlighted the need for disciplinary cooperation that would enable students to transfer knowledge across subjects. Some suggested discipline-specific additions to secondary curricula: "If in the secondary school curricula, they implement some managerial skills – at least how students can manage their time, their self, their career – that would facilitate the situation" (T33). An oral medicine teacher proposed including Latin for prospective medical students (T34).
These expectations point to an anticipated disconnect between university demands and secondary education practices, positioning pre-university education as a critical but insufficiently aligned phase of BMDL development.

5. Discussion

Three cross-cutting arguments emerge from the findings, each of which connects to and extends the existing literature.

5.1 Preparedness as a Multidimensional and Unevenly Developed Construct

The data indicate that teachers conceptualise student preparedness not as a single variable, typically language proficiency, but as an interconnected set of linguistic, disciplinary, and cognitive competencies expected to develop in tandem before university entry. This aligns with Hyland [14], who argues that academic success depends on engaging with discipline-specific practices rather than general language proficiency, and with McKinley's [10] framework, which positions higher education preparedness as encompassing disciplinary knowledge, academic socialisation, and critical engagement. This study adds that these dimensions are not only multiple but also unevenly developed. Teachers report students who possess reasonable language skills but lack disciplinary thinking, or who have content knowledge but cannot articulate it in the language of instruction. This unevenness, rather than any single deficit, is what generates classroom difficulty.
Importantly, the specific configuration of this unevenness is shaped by disciplinary orientation. Natural science teachers in our sample more frequently identified gaps in procedural and terminological knowledge in students who could not work with formulae, laboratory protocols, or technical vocabulary in English, while social science teachers emphasised deficits in argumentation, critical evaluation of sources, and the ability to construct disciplinary arguments in writing. This pattern suggests that "preparedness" is not a uniform construct but is refracted through the epistemological and communicative demands of each discipline. Kamaşak and Sahan [7] similarly found that the interaction between language proficiency and disciplinary knowledge shapes academic outcomes, but their analysis did not differentiate between disciplinary domains. Our findings extend this work by showing that the weight assigned to linguistic, cognitive, and content-related dimensions of preparedness varies systematically across the natural and social sciences, with practical consequences for how teachers allocate instructional time and adapt pedagogical strategies.

5.2 Systemic Misalignment between Expectations and Preparation

A persistent mismatch between what teachers expect and what students bring structures both teaching practices and learning experiences. Teachers' retrospective expectations of secondary education closely mirror the challenges they report in their own classrooms, suggesting that these challenges are not merely individual or pedagogical but reflect structural discontinuities between educational levels. This aligns with Yusupova et al. [15] and Pitera and Bush [12] on expectation-preparedness gaps and extends them by demonstrating that the pattern holds across four countries, two disciplinary domains, and three languages of instruction. Furthermore, Soruç et al.'s [6] student-focused data showed that language-related challenges interact with disciplinary knowledge; our teacher-focused data reveal a complementary perspective: these same interactions shape how teachers organise instruction, allocate time, and define pedagogical priorities.

What is particularly striking is the circular quality of this misalignment. Teachers reported spending considerable class time on vocabulary work, concept review, and foundational thinking skills, activities they explicitly framed as belonging to secondary education. This compensatory labour not only reduced the time available for advancing disciplinary knowledge but also reshaped instructional goals: several participants described shifting from discipline-building to remediation as their de facto classroom mode. Aizawa and Rose [8] documented a similar dynamic in Japanese EMI contexts, where limited secondary-level English exposure constrained university learning. Our cross-national data suggest that this is not confined to a single educational system but constitutes a recurrent structural feature of BMDL settings. The implication is that the misalignment is not only an inconvenience but a mechanism through which gaps in secondary preparation are reproduced at the tertiary level, as teachers must repeatedly revisit skills that were expected to have been developed earlier.

This finding underscores the need to reconceptualise BMDL development as a continuous trajectory rather than a stage-specific outcome. If preparedness is understood as something achieved by a particular educational threshold and then maintained, the burden falls entirely on secondary education. However, if it is understood as a cumulative, ongoing process, then the secondary-tertiary interface becomes a site of shared responsibility requiring coordinated curricula, shared expectations, and cross-level professional dialogue. Rose et al.'s [9] systematic review confirmed that students from L1-medium secondary schools face greater difficulties at university, particularly in academic writing; our data complement this by showing that teachers at the receiving end of this transition perceive the same discontinuity and respond to it with adaptive, but often unsustainable, instructional strategies.

5.3 The Limitations of Teacher Perception

It is important to recognise that these findings are based on teachers' perceptions, which may reflect normative expectations about adequate preparedness rather than objective measures of student ability. Teachers' accounts are inevitably shaped by disciplinary conventions, institutional demands, and idealised notions of what a "prepared" student looks like. From this perspective, the identified mismatch can also be interpreted as a gap between institutional expectations and diverse student trajectories, rather than solely as a deficit in student preparation. This interpretive caution aligns with Wollscheid et al. [11] in the sense that perceptions of academic literacy demands vary across disciplines and stakeholder positions.

Nevertheless, several features of the data work against a purely constructivist reading. First, the consistency of themes across four distinct national and institutional contexts, such as Türkiye, Albania, the Czech Republic, and Kuwait, suggests that the pattern captures a structurally real aspect of the secondary-tertiary interface rather than reflecting idiosyncratic institutional cultures. Second, teachers' accounts were not uniformly deficit-oriented; many participants acknowledged the constraints of their own pedagogical repertoires and the role of institutional factors, which suggests a degree of reflexivity that tempers the risk of one-sided attribution. Third, the specificity of teachers' expectations, their emphasis on particular skills such as argumentation, disciplinary vocabulary, and analytical thinking rather than vague complaints about "student quality", indicates that their perceptions are grounded in concrete classroom experiences rather than generalised dissatisfaction. Taken together, while the perceptual nature of the data warrants interpretive caution, the cross-contextual robustness and specificity of the findings support their value as evidence of a systemic pattern in BMDL instruction.

6. Conclusion

This study contributes to BMDL research by bringing together data from four countries, two disciplinary domains, and three languages of instruction to offer a cross-contextual, teacher-centred perspective on BMDL challenges. By connecting teachers' instructional difficulties to their retrospective expectations of secondary education, it highlights a dimension, the secondary-tertiary transition, that has been underexplored in the BMDL literature.The findings also carry several implications. First, secondary education should integrate DL, academic language, and critical thinking more systematically into curricula and develop these competencies progressively rather than abruptly introducing them at university. Second, universities should provide structured transition support such as bridging courses, academic literacy programmes, and discipline-specific language support to complement, not replace, secondary-level preparation. Third, greater alignment between secondary and tertiary education is essential, facilitated through coordinated curricula, shared expectations, and cross-level professional dialogue. Finally, blended professional development programmes engaging educators across levels could support a more coherent and continuous approach to BMDL development.

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The Impact of AI Avatars via Low-Immersion Virtual Reality on Foreign Language Anxiety, Motivation, and Speaking Proficiency among Japanese EFL Students

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Abstract

In today's globalized world, speaking proficiency in English is essential for academic, professional, and social participation. However, many learners in English as a Foreign Language (EFL) contexts have limited opportunities for authentic spoken interaction and often experience foreign language anxiety (FLA), which can inhibit oral performance. This issue is especially important for students preparing to study abroad, as short-term overseas programs require immediate communicative engagement in classrooms, homestays, and daily life. Pre-departure support that allows learners to rehearse realistic communication in a low-pressure environment may therefore be valuable. This pilot study examined whether one month of AI avatar-mediated speaking practice in low-immersion virtual reality (LiVR) was associated with changes in speaking proficiency, FLA, motivation, and learner acceptance among Japanese university EFL learners preparing to study abroad. Participants were 11 students enrolled in a one-month study-abroad program in Australia. They used the Immerse VR platform via personal computers to practice spoken English with AI avatars in simulated communicative environments. Data included pre- and post-intervention Versant speaking scores for all 11 participants, as well as FLA and motivation questionnaires completed by 10 participants who provided complete pre- and post-intervention data, and a post-intervention Technology Acceptance Model (TAM) questionnaire. Results showed a statistically significant and large reduction in FLA from pretest to posttest, whereas motivation remained high and stable. Speaking proficiency showed modest improvement, with the largest gain observed in vocabulary, although this effect did not remain significant after correction for multiple comparisons. Total time spent on the platform (Time on Site; TOS) was not significantly associated with gains in speaking or changes in anxiety and motivation. TAM results indicated moderately positive learner perceptions, especially regarding enjoyment, usefulness, and ease of use, although convenience and access appeared somewhat limited. These findings suggest that AI avatar-mediated LiVR speaking practice may be a useful pre-departure support tool, particularly for reducing speaking-related anxiety among Japanese EFL learners.

Keywords: *low-immersion VR; AI avatars; foreign language anxiety; speaking proficiency; study abroad preparation*

1. Introduction

In today's globalized world, English is widely used for international communication, making speaking proficiency an essential skill for academic, professional, and social participation [1–3]. However, many learners struggle to develop speaking ability because they have limited opportunities for authentic interaction, experience speaking-related anxiety, and often lack access to immersive communicative environments [4–6].

These challenges are particularly evident in EFL contexts such as Japan, where classroom instruction often prioritizes reading and grammar over speaking. Students frequently participate in study-abroad programs with limited speaking readiness, and may have few opportunities to use English spontaneously in realistic settings before departure. This lack of communicative practice may hinder the development of speaking proficiency and may also contribute to foreign language anxiety (FLA), which has been shown to negatively affect oral performance and willingness to communicate [4, 7, 8, 9, 10]. In contrast, positive beliefs about language learning and increased self-confidence are associated with lower anxiety and greater engagement in speaking [11]. Supporting learners in reducing FLA may therefore be an important step toward improving spoken English.

The program investigated in this study was a one-month study-abroad program in Australia for Japanese university students, with goals including improving English proficiency and fostering intercultural

understanding. Because such programs provide limited time for adjustment, pre-departure tools that allow learners to rehearse realistic communication may help them engage more actively once abroad.
One promising response is the use of virtual reality (VR), which can provide safe, interactive, and context-rich spaces for language practice [12, 13]. VR enables learners to engage in simulated environments that resemble real-world communicative situations, potentially increasing engagement, motivation, and confidence while reducing affective barriers. In language education, prior research suggests that VR can support speaking development, willingness to communicate, and anxiety reduction, although findings regarding measurable gains in speaking proficiency remain mixed and context-dependent [14–18]. This suggests that VR may be particularly effective for affective outcomes, while its impact on speaking performance requires further investigation.
VR can also be classified according to the degree of immersion: low-immersion virtual reality (LiVR) is typically accessed through desktop or mobile devices, while high-immersion virtual reality (HiVR) usually involves head-mounted displays [19]. The present study used LiVR, as students accessed Immerse VR via personal computer from school or home, making daily practice more feasible than HiVR.
Recent advances in artificial intelligence (AI), especially generative AI, have expanded the possibilities of VR-based language learning. AI conversational partners can provide learners with flexible, individualized speaking opportunities without requiring a human interlocutor, which may be especially beneficial for learners who are reluctant to speak in front of others [20–24].
Several VR platforms now incorporate AI avatars for speaking practice in simulated real-world environments. Initial research on VR-based language practice suggests that such environments can be motivating and enjoyable for learners [25, 26]. Motivation is recognized as a key driver of language learning effort and achievement [27, 28], and the ideal L2 self—the vision of oneself as a successful future language user—has been proposed as a central motivational force in second language acquisition [29]. Assessing motivational change requires reliable measurement instruments such as the Attitude/Motivation Test Battery [30]. Learner acceptance of educational technology is also a critical factor, as captured by the Technology Acceptance Model [31], which has been applied in mobile-assisted language learning contexts to examine how perceived usefulness and ease of use influence continued engagement [32]. Nevertheless, relatively few studies have examined AI avatar VR as a pre-departure speaking support tool for Japanese EFL learners, and fewer still have addressed anxiety, motivation, speaking performance, and technology acceptance within a single design. To address this gap, the present study investigates whether one month of AI avatar–mediated speaking practice in VR is associated with changes in foreign language anxiety, motivation, and speaking proficiency, and examines learners' acceptance of the technology after the intervention.

1. Does practicing speaking with AI avatars in LiVR reduce foreign language anxiety?
2. Does practicing speaking with AI avatars in LiVR increase motivation to learn English?
3. Does practicing speaking with AI avatars in LiVR improve speaking proficiency?
4. How do students perceive the technology of Immerse VR?

2. Method

2.1 Participants

The participants were 11 Japanese university students preparing for a one-month study-abroad program in Australia that included homestay and general English instruction. All 11 students completed the Versant speaking test at both time points, while 10 students provided complete pre- and post-intervention questionnaire data; one participant did not complete both questionnaires and was therefore excluded from the questionnaire-based analyses. Based on pretest Versant scores, four students were classified at CEFR B1, four at A2+, and three at A2.

2.2 Intervention and Setting

The intervention consisted of one month of AI avatar-mediated speaking practice using the Immerse VR platform, which provided simulated communicative environments including airports, restaurants, parks, and supermarkets. The intervention was implemented as LiVR, as this was more accessible and feasible for sustained daily practice than HiVR, which requires head-mounted displays and involves higher cost and technical demands. Students were asked to practice speaking every day using a personal computer from school or home. To structure their practice, students kept a speaking journal in which they recorded the topic category practiced each day using an initial letter: Socializing (S), Life and Living (L), Home

and Community (H), Expressing Feelings (E), and Managing Communication (M). These five categories were pre-selected by the instructor from study-abroad-related scenes available on the Immerse VR platform. At the end of the month, students wrote an overall reflection on their experience with the platform as the final journal entry. The journal data are not analyzed quantitatively in the present study and are reported here as contextual information.

2.3 Measures

Speaking proficiency was assessed with the Versant Speaking Test (scores range from 20 to 80) administered before and after the intervention for all 11 participants, reporting fluency, pronunciation, sentence mastery, vocabulary, overall score, and intelligibility. FLA and motivation were measured using pre- and post-questionnaires completed by all students; however, one participant did not complete both time points, resulting in a final questionnaire sample of 10. The FLA scale consisted of 24 items adapted from the Foreign Language Classroom Anxiety Scale, and the motivation scale consisted of 8 items, both using a 5-point Likert format. All 11 students completed an 18-item post-intervention TAM questionnaire evaluating the VR platform (Cronbach's alpha = .85).

2.4 Data Analysis

Pre- and post-intervention comparisons were conducted using paired t tests, Wilcoxon tests, effect sizes, and Holm-adjusted p values for Versant outcomes. Questionnaire reliability was assessed using Cronbach's alpha. Correlational analyses examined associations between total time spent on the platform site (Time On Site: TOS) and changes in all major outcome variables.

3. Results

3.1 Preliminary Analyses

Questionnaire analyses were based on 10 students, as one participant did not complete both the pre- and post-questionnaires and was therefore excluded from the questionnaire-based analyses. The FLA scale (Q1-Q24) demonstrated high internal consistency at both time points, with Cronbach's alpha of .922 at pretest and .967 at posttest, indicating that the scale measured a coherent construct reliably across the intervention. The motivation scale (Q25-Q32) showed lower but usable reliability, with Cronbach's alpha of .608 at pretest and .678 at posttest. While these values fall below the conventional threshold of .70, they are considered acceptable for exploratory classroom-based research with small samples, and motivation findings should accordingly be interpreted with some caution.

3.2 Foreign Language Anxiety and Motivation

Table 1 presents the pre- and post-intervention means, standard deviations, mean differences, significance levels, and effect sizes for both the FLA and motivation scales. FLA decreased substantially from pretest to posttest. The mean FLA score fell from 3.304 (SD = 0.594) at pretest to 2.471 (SD = 0.880) at posttest, a reduction of 0.833 points on the five-point scale. This decrease was statistically significant (p = .001) and associated with a large effect size (d = -1.518), indicating that the magnitude of anxiety reduction was both reliable and practically meaningful. The increase in standard deviation from pretest to posttest suggests that students responded somewhat differently to the intervention, with some experiencing greater anxiety reduction than others.

Table 1. Pre- and Post-Intervention Foreign Language Anxiety and Motivation Scores

Measure	N	Pre M	Pre SD	Post M	Post SD	Mean Diff	p	Effect Size (d)
FLA (Q1-Q24)	10	3.304	0.594	2.471	0.880	-0.833	.0010	-1.518
Motivation (Q25-Q32)	10	4.163	0.373	4.213	0.417	+0.050	.737	0.109

Note. Higher FLA scores indicate greater anxiety; higher motivation scores indicate stronger motivation. One participant was excluded due to incomplete data.

By contrast, motivation remained high and stable at both time points. The mean motivation score increased only slightly from 4.163 (SD = 0.373) at pretest to 4.213 (SD = 0.417) at posttest, a difference

of 0.050 points that was neither statistically significant (p = .737) nor practically meaningful (d = 0.109). These results suggest that students entered the intervention with already relatively high motivation to learn English and that this motivation was maintained throughout the month of VR practice without showing a measurable increase.

3.3 Speaking Proficiency

Table 2 presents pre- and post-intervention Versant speaking scores across all six measured dimensions for all 11 participants, including paired t test results, Wilcoxon signed-rank test p values, paired effect sizes (dz), and Holm-adjusted p values to correct for multiple comparisons. Overall, scores showed modest improvements across most dimensions, though none of the changes remained statistically significant after Holm correction.

Vocabulary showed the strongest positive change, with a gain of 5.64 points and a large effect size (dz = 0.86). Although this reached significance before Holm correction (t(10) = 2.86, p = .017), it did not remain significant after correction (adjusted p = .101) and should therefore be interpreted cautiously.

The overall Versant score increased from 39.45 (SD = 6.07) at pretest to 42.55 (SD = 6.04) at posttest, a gain of 3.09 points. The effect size was moderate (dz = 0.58), and the uncorrected p value approached but did not reach conventional significance (t(10) = 1.91, p = .085; Wilcoxon p = .066). Gains in fluency (1.55 points, dz = 0.22), pronunciation (1.45 points, dz = 0.18), and sentence mastery (2.55 points, dz = 0.29) were smaller in magnitude and did not approach statistical significance before or after correction.

Intelligibility showed a negligible decrease from pretest (M = 3.36, SD = 0.50) to posttest (M = 3.27, SD = 0.47), a difference of only 0.09 points that was non-significant (p = .676) and trivial in effect size (dz = -0.13). This result indicates that intelligibility remained essentially unchanged over the course of the intervention.

Table 2. Pre- and Post-Intervention Versant Speaking Test Scores

Outcome	Pre M (SD)	Post M (SD)	Mean Diff [95% CI]	Paired t Test	dz	Wilcoxon p	Holm-Adjusted p
Fluency	33.55 (9.52)	35.09 (8.92)	1.55 [-3.07, 6.16]	t(10)=0.75, p=.473	0.22	.520	1.000
Pronunciation	39.36 (8.57)	40.82 (11.65)	1.45 [-4.08, 6.99]	t(10)=0.59, p=.571	0.18	.678	1.000
Sentence Mastery	45.36 (10.60)	47.91 (9.07)	2.55 [-3.40, 8.49]	t(10)=0.95, p=.362	0.29	.220	1.000
Vocabulary	44.09 (12.31)	49.73 (11.82)	5.64 [1.25, 10.02]	t(10)=2.86, p=.0169	0.86	.0186	.101
Overall	39.45 (6.07)	42.55 (6.04)	3.09 [-0.51, 6.69]	t(10)=1.91, p=.0847	0.58	.066	.423
Intelligibility	3.36 (0.50)	3.27 (0.47)	-0.09 [-0.56, 0.38]	t(10)=-0.43, p=.676	-0.13	.655	1.000

Note. N = 11. Positive mean differences indicate improvement from pretest to posttest. Holm-adjusted p values correct for multiple comparisons across six outcomes.

3.4 Time on Site and Individual Differences

Students' time on site (TOS) varied substantially, ranging from 0.78 to 28.83 hours (M = 8.61, SD = 7.43, Mdn = 7.02), indicating considerable individual differences in platform engagement despite the daily practice requirement. Correlational analyses examined whether greater TOS was associated with larger gains in speaking performance or more favorable changes in questionnaire outcomes. For the overall Versant score, Pearson's r was -.029 (p = .933) and Spearman's rho was -.105 (p = .759), indicating no meaningful association between TOS and speaking improvement. Similarly, no meaningful associations were found between TOS and changes in FLA (Pearson r = -.132, p = .715; Spearman rho = .042, p = .907) or motivation (Pearson r = .128, p = .724; Spearman rho = .132, p = .717). The same null pattern held for vocabulary gain (Pearson r = .421, p = .197; Spearman rho = -.200, p = .555), although the Pearson correlation was numerically larger and warrants monitoring in future studies with larger samples.

One exploratory finding warrants mention with considerable caution: TOS showed a positive association with pretest FLA scores (Pearson r = .663, p = .037). However, this result is likely sensitive to the

influence of the single highest-usage student (28.83 hours), who may have driven the correlation substantially. With only 11 participants, a single outlying data point can produce a nominally significant correlation that is not meaningful at the population level. This association should therefore not be interpreted as evidence of a reliable relationship between baseline anxiety and engagement, but rather as a hypothesis worth examining in larger future samples.

3.5 Technology Acceptance

Students completed the TAM questionnaire after the one-month intervention to evaluate their perceptions of the Immerse VR platform. The overall mean TAM score was 3.40 out of 5 (Cronbach's alpha = .85), indicating a moderately positive evaluation of the platform as a whole.
The highest-rated dimensions were enjoyment, perceived usefulness, and ease of use, each with a mean of 3.86, indicating moderately positive perceptions in these areas. Students appear to have found the platform somewhat useful and accessible, though these ratings fall in the mid-to-upper range of the scale rather than indicating strongly positive impressions. The lowest-rated item was 'I can learn English at any place with Immerse' (M = 2.43), which stood notably below the other items and suggests that location flexibility was a practical concern.

Discussion

The clearest finding of this pilot study was the substantial reduction in foreign language anxiety. Students' FLA scores decreased significantly over the one-month intervention, and the effect size was large (d = -1.518). This finding is consistent with the idea that AI avatar–mediated VR speaking practice may provide a lower-pressure environment for oral rehearsal before learners encounter real-world communicative demands [4, 7]. For students preparing to study abroad, this may be especially important because reduced anxiety may increase willingness to speak with teachers, peers, host families, and community members once abroad. Notably, the magnitude of the anxiety reduction observed here exceeded what is often reported in classroom-based interventions, which may reflect several features of the VR environment. Interacting with AI avatars rather than human interlocutors may reduce social evaluation concerns, as the perceived consequences of making errors in front of an avatar may be lower than in face-to-face communication, at least in terms of social evaluation anxiety [6]. The structure of the intervention may also have contributed to this outcome. The instructor pre-selected five study-abroad-related topic categories from the Immerse VR platform—Socializing, Life and Living, Home and Community, Expressing Feelings, and Managing Communication—ensuring that students practiced across a broad range of everyday communicative situations they were likely to encounter during their homestay and study-abroad program. This systematic rehearsal of functionally diverse scenarios may have gradually built a sense of readiness and reduced the anticipatory anxiety associated with speaking in unfamiliar communicative situations. In this sense, the present findings align with prior research suggesting that VR can support affective outcomes such as reduced anxiety and increased confidence [14, 17], even when measurable speaking gains are less consistent.
Motivation, by contrast, did not show a meaningful increase. However, this result should be interpreted carefully. Students' motivation was already high at pretest (M = 4.163 out of 5), leaving limited room for measurable growth. Rather than indicating that the intervention was ineffective, the stability of motivation scores may suggest that the VR practice helped sustain students' already strong motivational orientation during the pre-departure period. This interpretation is plausible in light of the program context: students who had already committed to an overseas learning experience are likely to have entered the study with a strong desire to improve, consistent with the notion of the ideal L2 self driving future-oriented language learning behavior [29]. Maintaining that motivation over a one-month preparatory period is itself a meaningful outcome. Future research might employ more fine-grained measures of motivational change, or capture fluctuations at multiple points across the intervention, in order to detect subtler shifts that a pretest-posttest design may miss.
The speaking results were encouraging but more tentative. Vocabulary showed the strongest positive change (5.64 points, dz = 0.86), and the overall Versant score also increased by 3.09 points, but neither remained statistically significant after correction for multiple comparisons. The pattern of gains is nevertheless noteworthy. Vocabulary showed the largest gain among the speaking dimensions assessed, though the reasons for this pattern remain speculative. One possibility is that the five topic categories may have exposed students to domain-relevant lexis across a range of everyday communicative contexts that VR environments are well suited to simulate [12]. Whether this thematic

structure contributed meaningfully to the observed gain, however, cannot be determined from the present data alone.

More broadly, this pattern is consistent with the mixed findings reported in the VR language learning literature, where positive affective outcomes tend to be more consistent than measurable speaking gains [14, 17]. One possible interpretation is that anxiety reduction may begin to emerge before detectable changes in speaking proficiency, particularly in short interventions [5]. Gains in confidence and reduced inhibition may need to accumulate before speaking improvement becomes observable, rather than co-occurring with it [5, 7], suggesting that longer intervention periods may be needed to translate affective changes into observable proficiency gains.

The lack of a clear relationship between time on site and learning outcomes also deserves attention. Greater use of the platform did not automatically lead to larger gains in speaking performance or stronger changes in anxiety and motivation. This suggests that the sheer amount of practice alone may not be sufficient to explain outcome differences. One particularly interesting exploratory finding was the positive association between baseline anxiety and time on site ($r = .663$), suggesting that more anxious learners may have engaged with the platform more frequently, possibly because the avatar environment may have felt like a less threatening space than face-to-face interaction [6]. If this pattern replicates in larger samples, it would have meaningful implications for how VR tools are positioned: not as general-purpose practice supplements, but as targeted interventions for learners who find human interlocutors especially threatening. Learner profiles and interaction quality therefore warrant closer investigation in future research.

Finally, the TAM findings support the practical feasibility of using AI avatar–mediated VR speaking practice in a pre-departure context. Students generally found the platform enjoyable, useful, and easy to use, which is encouraging given that learner acceptance is a prerequisite for sustained engagement with any educational technology [31]. These results are broadly consistent with prior findings on avatar-based VR practice, which has been reported as motivating and enjoyable by learners in similar contexts [25, 26]. At the same time, the relatively low rating for location flexibility points to a concrete design challenge. Because the intervention was implemented as LiVR on personal computers, practice was inherently tied to locations where a PC was available—a constraint that may have limited the frequency and spontaneity of engagement [19]. Transitioning to a smartphone-compatible platform could substantially increase accessibility and allow learners to practice in commuting time, at home, or in other informal contexts. This would also better align with the everyday, distributed practice patterns that second language acquisition research consistently associates with proficiency development. More broadly, these findings suggest that pedagogical promise and technical accessibility must be developed together: even a motivating and anxiety-reducing tool may underperform if practical barriers reduce the consistency of learner engagement.

Conclusion

Several limitations should be acknowledged when interpreting these findings. This was a small-scale pilot study with only 11 participants and a one-group pretest-posttest design without a comparison group, which limits causal claims. It cannot be concluded with certainty that the observed changes were caused solely by the VR intervention rather than by other aspects of pre-departure preparation or ongoing English learning. The intervention lasted only one month, time on site varied substantially across students, and some analyses were explicitly exploratory and may have been sensitive to outliers. Motivation scale reliability was also lower than that of the FLA measure, suggesting that motivational findings should be interpreted with caution. Despite these limitations, the findings suggest that AI avatar–mediated VR speaking practice may serve as a useful bridge between classroom learning and real-world communication for students preparing to study abroad, particularly in terms of reducing speaking-related anxiety. Future research should include larger samples, comparison groups, longer intervention periods, and more detailed analyses of the quality of learner interaction in order to clarify how and under what conditions AI avatar VR practice contributes to speaking development and anxiety reduction.

Note： FLA findings from this dataset were partially reported in a previous conference proceedings [Saito, Y., "The Impact of AI-Driven Speaking Practice in VR on Foreign Language Anxiety Among Japanese EFL Learners", The IAFOR International Conference on Education – Hawaii 2026 Official Conference Proceedings, pp. 319–329, 2026. DOI: 10.22492/issn.2189-1036.2026.30]. The present study extends that work by additionally examining speaking proficiency, motivation, technology acceptance, and the role of a structured speaking journal in the intervention design.

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Technology's Impact on the Learning Process: Preservice EFL Teachers' Perception

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Abstract

This work examines how digital tools, online resources, and emerging technologies, such as artificial intelligence, influence on English language acquisition from both learner and future educator perspectives. This qualitative study, developed at the largest state public university in southeast Mexico, adopted a small-scale exploratory approach using a focus group discussion with 22 preservice EFL teachers who participated voluntarily. The participants recognized significant advantages in accessibility and abundant resources (e.g., TikTok educational content and YouTube videos, etc.), and engagement through interactive formats. However, they emphasized substantial limitations in developing speaking fluency, contextual interaction, and affective dimensions, such as empathy and emotional support. Key concerns included distractions in online and hybrid settings, challenges in verifying student effort, and the overuse of tools that lack human judgment. As future teachers, participants discussed the evolving role of educators, shifting from information providers to facilitators, and advocated for the balanced and well-prepared integration of technology. Findings align with broader trends in EFL teacher education to foster digital literacy and human-centered pedagogy. The results may provide beneficial insights for teacher educators, curriculum designers and decision-makers.

Keywords: *Language learning, technology integration, English as a Foreign Language, preservice EFL teachers.*

1. Introduction

For more than two decades, professional training and labour markets have experienced constant disruption due to globalisation, the dominance of English as a *lingua franca* and rapid technological advancement (ETS, 2026; OECD, 2025). Consequently, educational institutions have been compelled to adapt to these trends where English language proficiency (ELP) is no longer a privilege but a fundamental necessity. In Mexico, as in the rest of Hispanoamerica, English as a Foreign Language (EFL) plays a pivotal role in preparing students for success in an international global market (Cronquist & Fiszbein, 2017). Just like in higher education worldwide, technological disruption has forced universities to transform educational practices by incorporating technology in the teaching and learning process (UNESCO, 2025; OECD, 2025), particularly in the EFL field.

Digital platforms, applications, social media content and artificial intelligence have created new opportunities (and challenges) for accessing unlimited resources, providing teachers and learners with instant access to materials, immediate feedback and practice opportunities (Al-Senafi et al., 2024). However, in the context of EFL programmes, the implementation of these tools raises questions about their effectiveness, equity, and the preservation of essential human elements in the learning process, such as interpersonal interaction, emotional support, and authentic communication (Omidvar & Meihami, 2025).

The Autonomous University of Yucatán (UADY by its Spanish initials), the largest public state university in south-eastern Mexico, offers an undergraduate programme to prepare EFL teachers (Zumarraga-Avila et al., 2024). As future educators, their perceptions of how technology impacts language learning and teaching can engender critical reflections in the Mexican higher education system, especially in the southeastern context, which is increasingly influenced by globalisation (Despagne, 2018).

2. Theoretical Framework

The present study is situated within the Technological Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler, 2006), which posits that effective technology integration in teaching is predicated upon the dynamic interplay of technological, pedagogical, and content knowledge. Within the domain of EFL teacher training, TPACK emphasises the necessity for preservice teachers to cultivate competencies that enable them to utilise digital tools not merely as supplementary components, but as

transformative elements that facilitate language acquisition while addressing contextual realities in regions such as southeastern Mexico. This framework is of particular relevance to the UADY Bachelor's degree programme in English Language Teaching, in which future educators navigate global demands for English proficiency amid varying levels of technological access. Complementary to TPACK, the Technology Acceptance Model (TAM) (Davis, 1989) explains user adoption of digital tools through perceived usefulness and ease of use, offering insights into preservice teachers' attitudes toward AI and other emerging technologies in language learning.

Empirical literature highlights the substantial advantages of technology in language acquisition, including personalised learning pathways, immediate feedback, and expanded access to authentic materials. AI-driven applications enable adaptive practice tailored to individual proficiency levels, fostering learner autonomy and motivation through interactive simulations and real-time corrections that traditional classrooms often cannot provide at scale (Dai, 2024; Eliott, 2023). In the context of EFL, the integration of smartphones and mobile technology with digital platforms has been shown to promote immersive exposure to English as a lingua franca. This development has the potential to transcend geographical boundaries, which are often a significant challenge in Hispanic settings, and to facilitate the development of skills that are aligned with the demands of the global labour market (Cronquist & Fiszbein, 2017). These affordances align with the study's first research question by demonstrating how technology can democratise resources and accelerate acquisition, particularly for preservice teachers envisioning their future roles in resource-constrained environments.

Despite these benefits, there are notable disadvantages, including equity gaps, overreliance on tools and the potential erosion of human interaction. In Mexico and other Latin American countries, disparities in digital infrastructure can exacerbate existing inequalities by limiting access for students in the south-east of the country, for example, and raising concerns about the digital divide (Despagne, 2018). Moreover, overreliance on AI could reduce opportunities for authentic communication, emotional engagement and cultural awareness, all of which are vital for language proficiency. This could result in superficial learning and diminished interpersonal skills (Omidvar & Meihami, 2025). These challenges inform the study's exploration of pre-service EFL teachers' perceptions, emphasising the need to balance technological mediation with pedagogical practices that preserve the core human elements of teaching and learning.

Technological mediation is having a profound impact on the role of EFL teachers, transforming them from traditional knowledge transmitters into facilitators, curators and mentors in hybrid environments. Pre-service teachers recognise that this evolution requires enhanced digital literacy and adaptive strategies to effectively integrate tools while providing emotional support and encouraging critical reflection (Karataş, 2024; Lu, 2025). In technology-rich settings, educators must address AI-generated content, promote digital citizenship, and design experiences that foster 21st century competencies such as collaboration and creativity. Examining this transformation through the study's second research question positions teachers as pivotal agents in mitigating challenges such as algorithmic bias and reduced spontaneity. This ensures that technology enhances, rather than supplants, human connection in EFL education.

Together, these theoretical and empirical perspectives offer a comprehensive approach to investigating pre-service EFL teachers at UADY. By centring their voices, the study sheds light on how technology integration can equitably support language acquisition and professional development in an increasingly globalised and technology-driven landscape. It also advocates for teacher training that strengthens TPACK competencies and critical awareness. This foundation enables a nuanced analysis of the advantages and disadvantages of technology integration, as well as the evolving roles of educators in Mexico's higher education context.

3. Objectives and Research Questions

In view of the paucity of evidence regarding the impact of technology on educational processes in the context of EFL teacher training, the present study aims to explore preservice EFL teachers' perceptions of technology's impact on the English language learning process, with emphasis on both learner experiences and future educator roles. The study seeks to identify the perceived advantages and disadvantages of digital tools, online resources, and emerging technologies (including AI) in English language acquisition, and to understand preservice EFL teachers' views regarding the evolving role of educators in environments mediated by technology. In the pursuit of these objectives, these two questions were addressed.

1. What advantages and disadvantages does using technology have on language acquisition?

2. In what ways is the role of EFL teachers affected by technological mediation?

4. Method

The present study adopted a qualitative exploratory approach that allowed for the discovery of participants' lived experiences and viewpoints. This design was considered appropriate on account of the fact that it facilitates an in-depth exploration of the perceptions, beliefs, and reflections of pre-service teachers amid a context in which evidence remains limited.

4.1 Participants

The population of the research comprised people enrolled in the Bachelor's degree programme in English Language Teaching at UADY, which currently has 140 students. Participants were selected using convenience sampling (Martínez-Salgado, 2012), which resulted in twenty-two junior students, who included three men and nineteen women, aged between 19 and 24 years old, who were not employed at the time of the study. They agreed to participate voluntarily. Whilst this methodological approach may compromise the generalisability of the findings, it proved to be an effective and practical solution for exploratory purposes, facilitating the collection of narratives within the research context.

4.2 Data Collection and Analysis

Data were collected through an open interview during a face-to-face focus group session. The discussion centred on four major topics: (1) resource accessibility; (2) engagement and motivation; (3) skills development and interaction, and (4) teacher role evolution. The session was audio-recorded with participants' permission and subsequently transcribed verbatim for analysis.
The information was analysed thematically, with initial coding, searching, revising and refining of themes (Braun & Clarke, 2021). The analysis was organised according to the study's research questions and focused on identifying patterns related to the advantages, disadvantages and implications of technology use in EFL learning.
Although the findings are specific to junior pre-service teachers at UADY and should not be generalised, they offer valuable insights that could inform future research and local teaching practices.

5. Results

The research questions aimed to identify the advantages and disadvantages of using technology in language acquisition, as well as the ways in which the role of EFL teachers is affected by technological mediation. In the following sections, the results are presented according to these research questions.

5.1 Advantages of Technology in Language Acquisition

Participants identified several advantages, three of which were particularly prominent, as shown in Table 1.

Table 1. *Advantages of technology in language acquisition*

Advantages	Frequency
(a) Abundant and diverse research resources	90% (20 participants)
(b) Engagement and motivation	55% (12 participants)
(c) Accessibility	32% (07 participants)

Source: Own elaboration

(a) Abundant and diverse research resources
This was identified as the most significant advantage due to the substantial quantity of freely accessible materials. Participants were not particularly concerned about the reliability of the sources, but rather how frequently they used them and whether they were useful for their purposes. Table 2 shows the digital tools most frequently used by the 90% of participants who agreed on this advantage.

Table 2. *Most frequently used digital tools and reasons*

Digital tool	%	Reasons
TikTok	45%	Useful for learning contextual phrases and everyday language, with short, replayable videos.
YouTube videos	30%	Wide variety of educational material, enabling them to learn new skills and expand their knowledge.
Duolingo	20%	Effective for vocabulary acquisition and self-learning.
Kahoot! and Google Translate	15%	Interactive way to practise vocabulary and have a more engaging learning experience.

Source: Own elaboration

(b) Engagement and motivation.
In this regard, twelve participants praised the dynamic, visually appealing and concise nature of digital content. They noted that it helps learners to maintain attention better than traditional lectures do and allows them to review material repeatedly at their own pace.
(c) Accessibility.
Some participants highlighted that online resources and classes are very helpful for students who live far from campus or face logistical challenges, such as transport issues. Some students spend over than two hours travelling to campus.

5.2 Disadvantages of Technology in Language Acquisition

Participants also identified four significant disadvantages listed according to frequency in Table 3.

Table 3. *Disadvantages of technology in language acquisition*

Disadvantages	Frequency
(a) Weaknesses in the affective domain	72% (16 participants)
(b) Limitations in speaking fluency and authentic interaction	63% (14 participants)
(c) Distractions	50% (11 participants)
(d) Assessment and student effort	36% (08 participants)

Source: Own elaboration

(a) Weaknesses in the affective domain.
Participants emphasised that technology and artificial intelligence (AI) lack empathy, emotional support, motivation, and the ability to respond to individual or unexpected student needs.
(b) Limitations in speaking fluency and authentic interaction.
They stressed that, although apps and artificial intelligence can support initial practice, achieving real fluency and engaging in contextual communication requires face-to-face interaction with teachers and peers. A representative comment was: "*There are other aspects where you need a teacher, such as practising fluency. I think it's better in a classroom with real people*".
(c) Distractions.
Participants acknowledged that they (or their classmates) frequently experience distractions during online classes.
(d) Assessment and student effort.
Some participants expressed concern about assessment and the difficulty of distinguishing genuine student work from AI-generated content.

5.3 Ways in Which Technology Affects the Role of EFL Teachers

Participants perceived that technological mediation affects the role of EFL teachers. However, they highlighted two main aspects:

1. All twenty-two participants (100%) strongly agreed that technology cannot replace human teachers, emphasizing that educators are essential for providing empathy, motivation, emotional support, and the ability to handle complex classroom situations and individual student needs. As one participant summarised, "*AI is not going to replace teaching, it's not capable of doing everything that a teacher can do".*

2. Fifteen participants (68%) noted a clear shift from the traditional role of information provider to that of facilitator and guide, since students can now access amounts of information instantly through digital tools and applications.

However, despite the fact that participants believe technology cannot replace teachers and that it has changed their role to that of facilitators, 81% (18) of them advocated for the balanced and thorough integration of technology. They recommended combining digital tools with sustained face-to-face interaction, as well as proper teacher training, in order to maximise the benefits of technology while preserving the human element of education.

6. Discussion

The findings of this study were revealing in that the participants recognised both the advantages and disadvantages of incorporating technology into the process of learning EFL in a balanced manner. It was also interesting to note that their perspective was influenced by the fact that, as future EFL teachers, they were able to put forward objective and realistic views regarding their future teaching practice.

The participants' emphasis on plenty and diverse resources (90%) is consistent with broader trends documented in the literature. Digital tools such as TikTok, YouTube, Duolingo, Kahoot!, and Google Translate offer learners immediate, contextualised, and self-paced input that is frequently inaccessible in traditional classrooms in terms of both quantity and variety (Hendar & Amalia, 2024; Alshraideh, 2021). This accessibility advantage is pertinent in the southeastern Mexican context, where logistical challenges such as long-distance transportation and financial limitations affect physical resource availability (Cronquist & Fiszbein, 2017).

Engagement and motivation benefits (60%) further support the idea that visually appealing, concise, and interactive digital formats can sustain learner attention better than traditional methods. However, the reported disadvantages such as weaknesses in the affective domain (72%) and limitations in speaking fluency and authentic interaction (63%) highlights a critical tension. The participants consistently noted that technology lacks empathy, emotional responsiveness, and the ability to manage unpredictable classroom dynamics. These concerns resonate strongly with studies that underscore the irreplaceable role of human teachers in providing socio-emotional support and fostering genuine communicative competence (Chounta et al., 2022; Omidvar & Meihami, 2025).

The perception that technology cannot replace teachers (100% agreement) and the identified shift from "information provider" to "facilitator" (68%) reflect a maturing understanding of digital transformation in education. This approach aligns with frameworks such as the Teacher Digital Competency model addressed by Falloon (2020) which emphasises that teachers should move beyond merely delivering content towards designing meaningful learning experiences that thoughtfully integrate technology. The fact that 81% of participants advocate balanced integration, combining digital tools with sustained face-to-face interaction, suggests that they are developing the critical digital literacy and pedagogical judgement necessary for effective technology-mediated teaching.

The widely acknowledged barriers were distractions in online settings (50%) and challenges in assessing and verifying student effort (36%), which are consistent with the OECD's (2026) observations on how digital technologies and generative AI can lead to increased cognitive overload, reduced focus, and 'metacognitive laziness' when students rely too heavily on automated tools. This complicates authentic assessment practices. Similarly, UNESCO (2025) highlights threats to academic integrity and the limitations of traditional assessment models in the generative AI era, emphasising the importance of preserving human judgement and meaningful learning interactions amid digital disruption. These issues are particularly relevant in EFL contexts, where the core learning goals are oral production and authentic interaction. Therefore, the findings support calls for hybrid pedagogical models that preserve human-centred elements while making use of technological possibilities.

The study's limitations include the small, convenience sample drawn from a single institution, which restricts generalizability. The focus group format, while fostering interaction, may have encouraged consensus views rather than fully capturing dissenting opinions. Nevertheless, the depth of reflection

obtained from these junior preservice teachers offers valuable insider perspectives on an evolving educational landscape in a regional context that is under researched.

7. Conclusion and Recommendations

The study's findings indicate that preservice EFL teachers view technology as a potent yet limited asset in the realm of English language acquisition. Digital tools and AI enhance resource accessibility, engagement, and self-learning, but they are not yet able to develop speaking fluency, authentic interaction, and the affective dimensions essential to effective language learning. Participants unanimously affirm that human teachers remain indispensable and foresee an evolution in the teacher's role toward that of facilitator and guide. They advocate for intentional, balanced integration of technology rather than wholesale substitution.

These findings contribute to the growing body of evidence on technology integration in EFL teacher education, particularly in Hispanoamerica contexts where globalisation and digital disruption intersect with local educational realities. They emphasise the necessity to equip future educators with not only digital competencies but also the critical faculties necessary to uphold the human element in language education.

The following recommendations may prove useful for educators, programme designers, decision-makers and, naturally, for future research.

(1) For teachers and programme designers.

- It is imperative to incorporate comprehensive training on critical digital literacy and AI literacy into the English Language Teaching curriculum. This should include practical experience in evaluating and adapting tools such as TikTok, YouTube, and generative AI for educational purposes.
- Design hybrid methodology courses that deliberately combine technology enhanced activities with face-to-face speaking practice and affective support strategies.
- Incorporate modules on the ethical use of AI, academic integrity, and strategies for detecting AI-generated content.

(2) For decision makers at UADY and similar Mexican universities.

- Invest in reliable infrastructure and equitable access to reduce the digital divide that currently prevents students facing logistical barriers from benefiting from technology.
- Promote faculty development programmes focused on blended and hybrid pedagogies that preserve human interaction.
- Establish clear institutional guidelines for technology use in assessment to address concerns about authenticity and verification of effort.

(3) For future research.

- Conduct large-scale, mixed-methods studies across multiple Mexican universities to compare the perceptions of pre-service and in-service EFL teachers.
- Explore the longitudinal impact of specific technology integration models on language proficiency outcomes (especially speaking skills) and learner affect.
- Investigate ways of integrating global digital tools with local Mexican educational values and contexts that are culturally responsive.

By adopting a balanced, human-centred approach to technology integration, teacher education programmes in Mexico and other regions can enhance the preparation of future educators to navigate an increasingly digital yet fundamentally relational profession. The present study lends further support to the notion that technology should serve as an adjunct to, rather than a substitute for, the empathetic and responsive teaching that lies at the heart of effective language education.

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From Survival to Communication: Effective Strategies for Teaching Czech to Erasmus+ Students

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Abstract

The aim of this article is to present methods and practical tips for teaching Czech to students coming to the Czech Republic for one or two semesters as part of the Erasmus+ program. The Czech Republic presents a specific linguistic environment in which communicating in everyday situations solely in foreign languages can be challenging, especially outside major tourist hubs. It is therefore essential to equip students with basic socio-cultural knowledge and language skills so they can cope with everyday situations in the Czech environment. To identify the specific situations in which students need Czech, we conducted a questionnaire survey between 2021 and 2025 with 163 respondents. The findings suggest that the Survival Approach, utilizing formulaic language, best meets the identified needs of incoming students by effectively supporting their willingness to communicate (WTC). At the level of specific teaching units, we found the Scaffolded Language Emergence (SLE) approach to be particularly useful. SLE not only encourages WTC but also minimizes the reliance on an intermediary language (typically English), addressing a common issue in Erasmus+ language courses.

Keywords: *Czech as a foreign language; Erasmus+; Survival Approach; formulaic language; Scaffolded Language Emergence*

1. Introduction

Study stays by international students at Czech host universities are an important part of the internationalization of higher education institutions, a process that receives significant attention in the strategic plans of most Czech universities, individual faculties, and other university departments. In this study, we are particularly interested in the mobility of international students who come to the Czech Republic through the Erasmus+ program, as these students make up the vast majority of students enrolled in beginner-level Czech language courses.

International students come to the Czech Republic from many different countries. In addition to students from Slavic countries, whose cultures are similar to ours, we primarily work with students from completely different cultural backgrounds. Students from Slavic countries often already have at least a basic knowledge of the Czech language and Czech culture upon arrival in our country; they know basic greetings and phrases, whereas students from non-Slavic countries usually have no command of Czech at all and use English as their primary language of communication. However, in many places in the Czech Republic, it is still difficult to communicate in English even in everyday situations (shopping, services, etc.).

This study aimed to identify the situations in which Erasmus+ students most frequently need knowledge of Czech, and, based on the survey results, to select effective teaching strategies and methods for teaching Czech to non-native speakers that will help our students succeed in those situations.

2. Theoretical Background

2.1 ERASMUS+

Based on the Support Study for the Erasmus+ 2021–2027 Interim Evaluation and the Erasmus+ 2014–2020 Final Evaluation, the Erasmus+ programme is defined as follows: Erasmus+ is the European Union's (EU's) programme in the fields of education and training, youth and sport. It is one of the EU's most visible success stories. It builds on the achievements of its long history, since the Erasmus programme was originally established in 1987, and also on those of other pre-existing European programmes in the fields of education and training, youth and sport, covering both intra-European as well as international partnerships. Erasmus+ was established in 2014 as a result of the integration of all previously existing EU programmes implemented during the period 2007-2013 in the fields of education,

training, youth and sport: Lifelong Learning1, Youth in Action, Erasmus Mundus, Edulink, Tempus, Alfa and Preparatory Actions in Sport.
The general objective of Erasmus+ is to support, in particular through learning mobility, the educational, professional and personal development of people in education, training, youth and sport in Europe and beyond, thereby contributing to sustainable growth, quality jobs and social cohesion, to drive innovation, and to strengthen European identity and active citizenship. It does this through: supporting and financing the mobility of individuals (Key Action 1, KA1); cooperation among organisations and institutions (Key Action 2, KA2); support to policy development and cooperation (Key Action 3, KA3); and teaching, learning, research and debates on European integration matters (Jean Monnet Actions, JMA) [1].
International students coming to Czech universities under the Erasmus+ program generally have the option to include beginner-level Czech language courses in their study plans during their stay in the Czech Republic. These courses are a full-fledged part of the so-called Learning Agreement, are awarded ECTS credits (at the University of West Bohemia, students earn 5 ECTS credits for completing the course), and both the sending and host universities must approve their inclusion in the student's study plan. Czech language courses for Erasmus+ students are also available to students arriving as Freemovers.
The number of students in the Czech language course for beginners at the University of West Bohemia is shown in the table below:

Table 1. Number of students from 2021 to 2026.

Students / Semesters	WS 21/22	SS 21/22	WS 22/23	SS 22/23	WS 23/24	SS 23/24	WS 24/25	WS 25/26	Total
Erasmus+ and Free Movers students at the UWB	144	102	144	96	162	84	165	168	1065
Students in Czech language courses	47	42	53	46	53	36	51	47	375

2.2 Czech as a Foreign Language

According to the Foreign Service Institute (FSI), the primary training institution for the U.S. Department of State, which prepares American diplomats and foreign affairs professionals for international assignments, the Czech language is considered difficult for English-speaking native speakers to learn. Based on the average time students need to reach a "Professional Working Proficiency," the FSI has divided languages into five categories. In the US government's language, this corresponds to a score of "Speaking-3/Reading-3" (S-3/R-3) on the Interagency Language Roundtable scale, roughly equivalent to B2/C1 on the Common European Framework of Reference for Languages. The Czech language is in the fourth category. Students usually need about 44 weeks, or 1100 class hours, to reach S-3/R-3. The languages in this category are described as languages with significant linguistic and/or cultural differences from English. The Czech language is in this category, along with several other Slavic languages, such as Slovak and Croatian, as well as Hungarian, Hebrew, Uzbek, Vietnamese, and Zulu [2].
Czech is a Slavic language. It is written using the extended Latin alphabet (the complete Czech alphabet, including diacritics, has 42 letters) and follows a predominantly phonological system. Most sounds are common in other languages as well, but many international students find it difficult to pronounce words containing clusters of consonants. Distinguishing vowel length is also often a challenge. However, the greatest difficulty in Czech lies in its complex grammar and rich vocabulary. Czech is an inflected language, meaning it not only conjugates verbs but also uses declension for nouns, adjectives, pronouns, and numerals. Declension means that a single word can take on multiple endings. By choosing the appropriate ending (which always corresponds to the relevant case), the speaker expresses the word's function in the sentence and its relationship to other sentence elements, such as whether it is the subject or object of the sentence. Thanks to declension, it is not necessary to adhere to a fixed word order in Czech as strictly as, for example, in English or French; the function of a word is expressed by its form, not its position in the sentence. Word order can thus, to a certain extent, help the speaker express finer nuances of meaning, since in Czech the most important information is usually at the end of the sentence. To express even more precise relationships between words, Czech uses a rich system of prepositions. Czech uses 7 cases in both the singular and plural and three grammatical genders, masculine (animate and inanimate), feminine, and neuter. In addition to the aforementioned

declension and rich prepositional system, students, especially those who do not speak a Slavic language, often find it difficult to use verb aspect correctly and to navigate the system of prefixes.
Given the nature of the Czech language and the need for students to learn to communicate, at least in the most common everyday situations, within a short period of time, the survival approach appears to be effective for this specific audience.

2.3 Survival Approach

The survival approach in language learning is not attributed to a single author, but rather to the combined work of applied linguists, educators, and language advocates who created these systems for travelers, expatriates, and endangered language preservation. A highly regarded work in this field is the 1991 study by applied linguists Paul Nation and David Crabbe, in which they outlined a functional-conceptual approach to creating survival-oriented thematic dictionaries for travelers. In their research, they prioritized short but highly useful phrases for immediate communication: The aim of this study is to provide a list based on a principled approach that will give learners an immediate and useful return for the effort of learning. A quick survey of introductory course books indicates that their syllabus content provides poor short term return for someone with limited time to invest. There is usually too much material in the early lessons that is not relevant to immediate needs. The first chapters often deal with topics like the indefinite article, pronouns, or adjectives, before coming to something that can be immediately used [3]. Nation and Crabbe have developed a study plan for short-term stays (1–3 months). They argue that it is worthwhile to learn the local language even during this period, but that intensive courses are ineffective in this case. They selected topics for the curriculum based on four criteria: 1. needs (they conducted a needs analysis of ten respondents), 2. frequency of occurrence of terms (they compared these with An English-French-German-Spanish Word Frequency Dictionary by Helen Eaton, 1940), 3. coverage and combinability, and 4. learnability.
No consideration has been given to special needs that the visitor may have as a result of the particular reason for visiting that country, such as to do academic research, to arrange a trade deal, or to get married. Rather, attention has been focused on survival, travel and social needs which would be common to any visitor to another country. This includes getting the necessities at a good price and basic social courtesies. The syllabus thus has two focuses: a focus on spoken language, on the assumption that in the mainstream tourist areas of a country, communication will be in a spoken form, and a focus on vocabulary [3].
In 2005, researchers from the University of Málaga published a paper that expanded on the original ideas of Nation and Crabb. They transformed the original thematic model into a functional-conceptual one, which is considered more versatile: A functional-notional syllabus was implemented so that it could better suit our students' needs by taking into account particular features such as age, mother tongue, language level, background knowledge, etc. This model, with few adaptations, was designed to cope with the linguistic problems that the students usually have in their first visit to an English-speaking country. Our syllabus was developed with the following objectives in mind: 1) to remedy our students' shortcomings by means of a survival model; 2) to check the validity of a functional-notional approach for this type of course; 3) to assess the students' motivation and acceptation of our model by incorporating computer-based sessions in the language lab. All in all, our model of survival English syllabus is featured by its versatility, as it may be adopted in any teaching environment, and its coverage and scope, as it enables the students to cope with most situations in ordinary life [4].
The survival approach is essentially pragmatic and deliberately limits the breadth of the curriculum in favor of practicality. Closely related to this is the concept of formulaic speech (henceforth FS), which is used in the survival approach. FS is based on sequences of words that speakers learn and use as unified "chunks" without necessarily understanding their internal grammatical structure: A formulaic form is learned in terms of its function. In FS, function has precedence over form, it is more relevant to consider formulas from a pragmatic point of view rather than from a syntactic one. In a Second Language Acquisition perspective, FS is shown as being a temporary stage of acquisition which, among other aspects, enables the speaker to reach idiomaticity in his or her L2 and thereby
efficient communication with native speakers [5].
The survival approach is not the only one that aims to enable complete beginners to achieve a basic level of communicative competence as quickly as possible. We now turn our attention to the Scaffolded Language Emergence approach.

2.4 Scaffolded Language Emergence

The American linguist Don Kiraly (Donald C. Kiraly), who worked at the University of Mainz in Germany, is considered the founder of the Scaffolded Language Emergence (henceforth SLE) approach. In his own words, the SLE approach is: a principled approach to fostering initial language emergence in adults. It is both firmly grounded in extensive experience and supported by a growing body of theory that sees language learning as an emergent, highly authentic, and collaborative process of language creation. The SLE approach has deep roots in three domains: 1) naturalistic, immersion type language learning as exemplified in a long lineage of language teaching methods, 2) the body of general educational thought revolving around the concept of social constructivism, which dates back at least to early 20th century progressive thinkers like Lev Vygotsky and John Dewey, and 3) the school of thought in the domain of language learning and acquisition studies that focuses on the ecology and complexity of language and both social and cognitive language learning processes. From an SLE perspective, conventional approaches to language teaching often purport to offer learners carefully packaged information about language to be accumulated through deduction from linguistic rules, rote memorization, and repetitive practice. SLE, on the other hand, advocates the creation of a naturalistic immersion environment in which adult learners, in particular, can explore and, in fact, generate within themselves a previously unknown language system through collaboration with peers and with one or more facilitators who nudge, guide, and scaffold far more than they instruct [6]. In the SLE approach, the teacher acts not as an authority figure but as a guide and co-creator of the language system, building a safe “scaffold” for students by creating opportunities for action and interaction, and providing support and feedback. As students’ autonomy increases, the teacher gradually removes the scaffolding. To beginners, linking language with physical movement is essential, which is why the Total Physical Response method is widely used in the SLE approach. The facilitator also deliberately combines speech with expressive gestures, facial expressions, and movement, thereby helping students grasp the meaning of language through physical experience and eliminating the need to translate into their native language. This engagement of motor memory and multiple senses leads to more effective acquisition of basic vocabulary and supports the natural emergence of language structures through bodily experience (embodiment).
Both the survival and SLE approaches rely exclusively on the target language.

3. Research

3.1 Methodology

Between 2021 and 2025, an online questionnaire (Google Form) was sent to most Erasmus+ and Freemovers students enrolled in beginner-level Czech language courses. The questionnaire was distributed at the end of the semester, and participation was voluntary. A total of 163 students participated in the survey. One of the survey’s objectives was to identify specific everyday situations in which these students most frequently need knowledge of the Czech language.

3.2 Research Design

In the section of the questionnaire devoted to identifying specific situations in which international students arriving in the Czech Republic need at least a basic knowledge of Czech, two open-ended questions were asked:
1. In what situations did you use the Czech language most often during your stay?
2. In what situations did you miss knowing the Czech language the most?
Question number two was divided into two parts: a) spoken Czech, b) written Czech.
We have categorized the responses to the above questions and present them in the following tables, along with the number of responses and the semester and year in which each response was provided. Answers that appeared in response to all questions are highlighted in the same color. Answers that applied to only one question are shown in white.

Table 2. Situations in which students most often use Czech during their stay in the Czech Republic.

Situations / Semesters	WS 21/22	SS 21/22	WS 22/23	SS 22/23	WS 23/24	SS 23/24	WS 24/25	WS 25/26	Total
Shopping	15	17	10	9	10	12	16	18	107
Restaurants, bars	11	3	4	3	3	9	9	13	55
Interactions in public, with friends, in school	1	2	1	2	2	5	3	7	23
Services, leisure time	4	1	1	0	2	0	2	3	13
Accommodation	1	2	3	1	1	2	2	1	13
Transport and navigation	4	1	0	2	1	0	1	3	12

Table 3. Situations in which students miss the most spoken Czech skills.

Situations / Semesters	WS 21/22	SS 21/22	WS 22/23	SS 22/23	WS 23/24	SS 23/24	WS 24/25	WS 25/26	Total
Shopping	18	4		6	2	5	2	3	40
Interactions in public, with friends, in school	4	8	1	5	3	4	6	4	35
Restaurants, bars	6	1		2		1	1	5	16
Accommodation and householding	1	1	1	1	1	4	2	3	14
Transport and navigation	4			2	3		3		12
Services, leisure time	3						2	1	6
Health services	2	1						2	5
Post office	2								2

Table 4. Situations in which students most often miss written Czech skills.

Situations / Semesters	WS 21/22	SS 21/22	WS 22/23	SS 22/23	WS 23/24	SS 23/24	WS 24/25	WS 25/26	Total
Restaurants, bars	4	3		2	2	2	1	2	16
Shopping		2		4	3		2		11
Transport and navigation	3	2	2	1			1		9
E-mails	5			1			1	1	8
Websites (university and others)	3				1		2	1	7
Interactions in public, with friends, in school	3		1	1					5
Accommodation and householding			1	1				1	3
Cooking instructions		2						1	3
Street signs							1	2	3
Services, leisure time	1	1							2
Facebook events	1								1

3.3 Analysis of the Communication Needs of International Students

The purpose was to determine in which communication situations students most often need knowledge of the Czech language. Question 1 addresses this objective. Question 2a was included to determine whether there are, even if rare, situations in which knowledge of Czech is absolutely essential for students. For many students, the answers to Question 1 and Question 2a differ; for many others, the answers to both questions are the same; and some students responded that they did not understand the question. We received the fewest responses to Question 2b, and some students also stated they did not understand the question.
An analysis of all responses to both questions clearly shows that students need the most knowledge of Czech in the following areas: shopping, restaurants and bars, interactions in public spaces, including interactions with friends and at school, transportation and city orientation, accommodation and householding, and services and leisure. In the responses to Question 1: In what situations do students most often use Czech, and Question 2a) In what situations did students most lack knowledge of spoken Czech, the same topics appeared in the top three spots (in varying order): shopping, restaurants and bars, and interactions in public spaces, with friends, and at school. This result confirms that these topics are essential in spoken language for students. In the responses to question 2b) “In what situations did students most lack knowledge of written Czech?”, the topic of transportation and city orientation appeared in third place, alongside shopping, restaurants, and bars. The topic of transportation and navigating the city ranks fourth in the overall ranking of all responses to all questions, so it is also very important. This is followed by the topics of accommodation and householding, and services and leisure. Given that our study focuses on students (who have secured housing) rather than travelers, and that in today’s age of modern technology, the need to ask for directions has receded into the background, we can conclude that our findings largely confirm the results presented in the 1991 study by Paul Nation and David Crabbe, who identified the following most common communication situations: 1. Greetings and being polite, 2. Buying and bargaining, 3. Reading signs, 4. Getting to places, 5. Finding accommodation, 6. Ordering food, 7. Talking about yourself and talking to children, 8. Controlling and learning language [3].

3.4 Choosing Appropriate Teaching Methods and Strategies

Most international students come to our university for one semester. The semester lasts 13 weeks. Czech language courses for Erasmus+ students are held twice a week for 90 minutes. Teaching methods and approaches should be chosen that enable students to communicate effectively in the most common everyday situations in a Czech-speaking environment within a short time. As explained above, these needs are met by the Survival and Scaffolded Learning approaches. In our Czech language courses for Erasmus+ students, we use a combination of both approaches, incorporating elements of other methods.
Over the years, we have gradually refined our teaching methods and the selection of specific activities based on our observations of how well the approaches and activities used in the courses worked, as well as on more spontaneous student feedback. The selection of topics reflects our ongoing evaluation of the questionnaires mentioned above. We therefore consider shopping, dining situations in restaurants, and greetings, introductions, and basic interactions in public places and with friends to be the most essential communication situations for our students.
Unfortunately, in our setting, we do not have two native speakers in our courses, as described in the SLE approach, so for introductory conversations, we either use video materials or have one instructor outline the situation. In some cases, it is possible to conduct a conversation with one of the more advanced students, typically those from Slavic-speaking countries. At least during the first two sessions, we do not use any written language materials. This approach, which promotes correct pronunciation and is used in SLE, has proven very effective for us in other language courses as well, such as French courses for absolute beginners. Students rely on their auditory memory, which is constantly stimulated in class by new but regularly recurring stimuli. However, we combine the audio track with gestures, movement, and other elements to engage as many senses as possible. We strive to adhere to the principle of using only the target language and to make the most of real-life objects and situations, as well as role-playing exercises. Each lesson concludes with an activity or game that allows students to apply what they have learned actively. As for declension, the main focus is on students’ understanding of its meaning and function. During the course, attention is given only to the accusative case, which is used when shopping and ordering at a restaurant. For review and practice at home, we prepare a range of online activities for students in the Wordwall app, such as memory games where they match an image

with a sound, and later with a written word; moving words to practice correct sentence structure; selecting the correct forms; sorting words; and so on.
Presenting the specific activities for each topic over the entire semester would be an ambitious goal that would go far beyond the scope of this article; therefore, we will provide a detailed overview of the very first lesson.

3.5 First Learning Unit - Detailed Description

We naturally introduce the "Greetings and Introductions" communication unit right at the first meeting with the students. The teacher greets the students and introduces themselves in a very simple way, using a set phrase: *"Ahoj, já jsem + name"* (Hello, my name is + name), accompanying the introduction with gestures. Then the teacher invites the students to come up, introduces themselves again, and asks, *"A Ty? Jak se jmenuješ?"* (And you? What's your name?) This question corresponds to the informal speech that students will use more frequently. Everything is accompanied by precise gestures and a distinct intonation. The teacher observes which students have understood the question, turns to them, and uses the previously employed gestures for introductions to prompt their responses. When the student responds, the teacher adds the reaction: *"Těší mě."* (Nice to meet you), again accompanied by a gesture. In this way, all students introduce themselves. Once all students understand this situation and can introduce themselves informally, the teacher explains, using gestures, that this way of speaking is informal, but that Czech also uses a formal style. Then the teacher uses the same gestures for greeting and introducing oneself, but this time accompanies them with formal language: *"Dobrý den. Já jsem + name. A Vy? Jak se jmenujete?"* (Good morning. My name is + name. And you? What is your name?) Students generally understand the difference very well. The teacher then addresses the students in both a formal and informal manner. During the exercise, the teacher suddenly says clearly: *"Promiň, nerozumím. Ještě jednou, prosím."* (Sorry, I don't understand. One more time, please.) The teacher again accompanies the speech with gestures. If the students do not understand, the teacher repeats the question and adds the previous question: *"Jak se jmenuješ?"* (What is your name?) Once all students understand the content, the teacher also uses the formal form: *"Promiňte, nerozumím. Ještě jednou, prosím."* (Excuse me, I don't understand. One more time, please.) The teacher then addresses the students in both formal and informal ways, and they complete the micro-dialogue in the same tone, depending on the form the teacher has chosen. After practicing both formal and informal ways of introducing oneself, during which all the students' names were mentioned repeatedly, the teacher surprises the students with a sentence accompanied by a gesture: *"To je + name of student."* (That's + student's name.) In this way, the teacher introduces several students and then asks: *"To je + student´s name?"* (Is this + student's name?) The teacher answers: *"Ano, to je + student´s name."* (Yes, this is + student's name), thereby showing the students the affirmative response. The answer is again accompanied by a gesture. After several repetitions, the teacher explains the negative form in the same way *(No, this is not + student's name).* The final question in this first part of the lesson is: *"Kdo je to*?" (Who is this?) The teacher points to a student, asks the question, and gestures to indicate they don´t know who it is. After a brief practice session and summary, students are invited to an Erasmus+ student party where only Czech is spoken. There, they can now get to know each other in Czech, simply ask who someone else is, introduce someone, or say that they don't understand and need the other person to repeat what was just said. Students are repeatedly encouraged to use the gestures they have learned to accompany the corresponding utterances.
In the second part of the first lesson, the teacher will introduce students to several basic concepts from everyday life, specifically a book, a notebook, a pen, a table, a chair, a window, and a door. As mentioned above, Czech uses seven cases; the goal of this section is not only to teach students the words in their basic form but also to familiarize them with the fact that every noun has multiple forms. To do this, the teacher will use specific objects, showing them to the students in various situations and commenting on these situations: *"To je kniha. Kniha je malá. Otevřu knihu. Zavřu knihu. Položím knihu na stůl. Teď je kniha na stole. Je to moje kniha."* (This is a book. The book is small. I'll open the book. I'll close the book. I'll put the book on the table. Now the book is on the table. This is my book.) At the end, the teacher asks: *"Co je to?"* (What is this?) The students usually answer correctly: *"To je kniha."* (This is a book.) In this way, the teacher introduces all the objects. At the end of each demonstration, the teacher asks: *"Co je to?"* (What is this?) and, after hearing the correct answer, uses the same question to review the entire series of already familiar objects. This is followed by a review of negation, after which the teacher invites the students to follow their instructions and manipulate the objects whose names they have just learned. During the demonstration, verbs associated with multiple objects (open/close a book, a notebook, a window, a door) were intentionally used so that students could

generally understand. This activity is very well received by the students, who are generally motivated by the realization that they understand the instructions in Czech. Next is an activity in which students keep their eyes closed and identify and name objects based on the sounds they make. The final activity is a conversation in which we simulate a meeting between Erasmus+ students and Czech students. Students try to apply everything they have learned during the lesson. In 90 minutes, they learned how to: greet others and introduce themselves (formally and informally), ask someone's name, say they don't understand, ask for something to be repeated, and name basic everyday objects. They know that in Czech we use formal and informal forms of address, as well as declension; they have mastered the third-person singular form of the verb "to be," which is irregular and often causes problems; and they understand the difference between the pronouns "co" and "kdo."

4. Conclusion

For international students who come to the Czech Republic for one or two semesters as part of the Erasmus+ program, the Czech language poses a significant challenge. Given that, outside major tourist centers, communicating in English in everyday situations remains difficult, it is crucial to equip students quickly with a functional foundation in the language. An analysis of communication needs conducted among 163 respondents clearly identified shopping, visits to restaurants and bars, and basic social interaction in public and school settings as priority areas. These real-life needs of students largely align with the themes identified by Paul Nation and David Crabbe as early as 1991. A combination of the "Survival Approach" and the "Scaffolded Language Emergence" (SLE) approach proved highly effective for this specific group of students within the limited time frame (a 13-week semester with two 90-minute classes per week). Teaching based on fixed phrases (chunks) allows students to achieve immediate communicative success, which significantly boosts their willingness to communicate (WTC) in real-life situations. Furthermore, the SLE approach effectively addresses a common problem in international courses, namely excessive reliance on a bridge language (typically English). Thanks to its emphasis on multisensory learning, gestures, facial expressions, and the Total Physical Response (TPR) method, this model eliminates the need for translation and promotes the natural "emergence" of language structures through physical experience. The practical application in the first teaching unit demonstrated that even complete beginners can master the basics of social etiquette and name several objects in the target language within 90 minutes. The proposed strategy thus represents a viable alternative to traditional grammar-centric methods and provides students with tools for effective integration into the Czech sociocultural environment.

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Workplace-Oriented German Training for Engineers: A Needs-Based Practice Report from a Multinational Company

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Abstract

Teaching German in a highly specialised civil engineering environment quickly showed that grammar and textbooks alone were not enough. The civil engineers needed to explain technical processes, discuss reports, solve problems, and communicate professionally between Germany and Greece. This required a more flexible and workplace-oriented approach to language teaching. This paper reflects on a longitudinal language training program developed and continuously adapted between 2022 and 2026 at STATIKS IKE in Thessaloniki, Greece and RADIN Planungsgesellschaft Tragwerke mbH in Lippstadt, Germany. Both companies operate within the same transnational engineering environment under shared management. The program originally began with nineteen participants and continues today with a core group of nine civil engineers. This development reflects both professional mobility within the company and the personal and professional development of the participants over time. The learners ranged from A1 to C2 levels and were organised into six individual level groups as well as three broader groups (A1–B1, B2–C1, and C2). The groups attended weekly ninety-minute lessons, mainly in person and, when necessary, online. One of the central pedagogical challenges throughout the program was the gap between receptive understanding and active communication. Many engineers were able to read and understand German technical documentation quite fluently but experienced difficulties when they had to explain the same content independently in speaking or writing. Addressing this gap required more than traditional communicative exercises. Over time, the program developed into a more dynamic and adaptive teaching process that continuously changed in response to the learners' professional realities, communication challenges, and workplace situations. The development of the program was therefore not linear, but shaped by ongoing reflection, experimentation, and adaptation. The training gradually combined task-based and needs-based approaches, authentic professional materials including reinforcement plans (Bewehrungspläne) and soil reports (Bodengutachten), case-based learning, intercultural reflection and, authentic professional and everyday communication in an increasingly AI-influenced workplace environment shaped by fast daily communication. The findings suggest that effective language training in technical contexts requires continuous adaptation, genuine engagement with the learners' professional environment, and a willingness on the part of the educator to learn alongside the discipline being taught.

Keywords: *Languages for Specific Purposes (LSP), workplace-oriented language training, task-based learning, intercultural communication, adaptive language teaching, engineers*

1. Introduction

General German language instruction alone often does not prepare engineers sufficiently for the communication demands of a technical multinational workplace. That observation may sound obvious, yet many language programs for professional contexts still begin with general linguistic frameworks, as I initially did myself, before gradually introducing professional content. In practice, this often produces learners who can discuss grammar but struggle to lead a technical meeting or explain complex professional problems independently [1, 6]. The program described in this paper did not begin as a specialised engineering language course. Like many DaF programs, it initially followed more traditional general language teaching approaches and materials from established DaF publishers. Over time, however, the professional realities of the engineers increasingly shaped the direction of the training and gradually transformed it into a more workplace-oriented and adaptive form of language instruction, particularly at the B2–C1 levels, while the lower A1–B1 levels remained more strongly connected to general DaF instruction. STATIKS IKE in Thessaloniki, Greece, and RADIN Planungsgesellschaft Tragwerke mbH in Lippstadt, Germany, do not function as two separate companies in partnership, but as part of the same transnational engineering environment under shared management. The Greek

engineers work on German projects, read German technical documentation, communicate with German clients, and, for those who travel to Lippstadt, often work for extended periods in an entirely German-speaking professional environment. Their need for German is therefore immediate and directly connected to their daily professional responsibilities [2, 3, 27]. I began working with this cohort in September 2022 with a group of nineteen participants ranging from complete beginners at A1 to learners at C1 level. The reduction from nineteen to nine participants over four years reflected professional mobility, including career changes and relocation. Since September 2025, the program has also included two C2-level civil engineers, one of whom is a company director within the firm. The participants were divided into two broader level groups, A1–B2 and B2–C1, while the C2 participants attended lessons together with the advanced group. Each group met once a week for ninety minutes, almost always in person. This choice was deliberate, as many of the communicative tasks that proved most valuable in this context involved spontaneous technical explanations, simulated professional meetings, and forms of interaction that required participants to think and speak simultaneously [4, 5]. At the same time, remote teaching also became part of the program when necessary. In this particular context, online lessons proved to be similarly effective, mainly because the participants were already accustomed to close professional collaboration, regular communication, and highly interactive lesson formats. Workplace communication problems frequently became teaching material themselves. A site report that used unfamiliar terminology. An AI-generated translation that had caused a professional misunderstanding. Over time, the engineering workplace itself increasingly became part of the curriculum, which made the training both more demanding and, in many cases, more effective [5, 6, 11]. Several participants undertook external German courses alongside the in-company training, pursued formal language certifications, and completed immersive work placements at the Lippstadt office for two weeks to three months [6, 15].

2. Theoretical Background

2.1 Languages for Specific Purposes (LSP) and Needs Analysis

The theoretical foundation of this program is situated within Languages for Specific Purposes (LSP), an approach based on the idea that language learning becomes more effective when it is closely connected to the real communication demands of a specific professional context [6, 10]. In structural engineering, communicative competence has a very practical meaning: the ability to read and critically assess a soil report, explain the implications of a foundation calculation to a non-specialist client, or lead a technical meeting in which questions of safety, responsibility, and project cost are discussed simultaneously [2, 3]. General linguistic competence is necessary for this, but on its own it is often not enough. Needs analysis became a central component of the program. One of the most important lessons this teaching experience revealed was that workplace needs cannot be analysed once at the beginning of a course and then treated as fixed. Professional communication practices and workplace priorities change continuously. The communicative challenges engineers faced in 2022 were not identical to those they encountered in 2025, particularly given the growing presence of generative AI in workplace communication during that period [5, 12]. For this reason, needs analysis became part of the weekly rhythm of instruction. Participants were regularly encouraged to bring current workplace communication problems and ongoing projects into the classroom, transforming professional difficulties into teaching material and creating a continuous feedback process between the engineering workplace and the language learning environment [5, 11]. Over time, this also contributed to a more adaptive form of language teaching in which workplace realities increasingly shaped lesson content and communicative priorities.

2.2 Task-Based Language Teaching, Scaffolding and Writing-To-Learn

Task-Based Language Teaching (TBLT) became one of the main methodological approaches of the program and was closely connected to the idea that language learning develops most effectively through active participation and meaningful interaction rather than passive reception [4]. A recurring challenge throughout the program was the gap between receptive understanding and productive communication. Many participants were able to understand highly complex technical information but struggled to explain it independently in German. Over time, the program therefore increasingly adopted an output-oriented perspective, encouraging learners not only to process technical language but to actively use it in professional interaction. This distinction became particularly important in workplace-related situations. When an engineer practised explaining a structural problem not as an isolated grammar exercise but as

part of a simulated professional interaction, participants often became noticeably more engaged and personally invested in the activity. In this sense, TBLT was also closely connected to scaffolding practices inspired by Vygotsky's zone of proximal development, the idea that learners progress most effectively when support is carefully adjusted to their current abilities and gradually reduced as confidence and competence grow [19]. Particular importance was also given to recurring professional expressions and formulaic language, since fluent workplace communication often depends less on isolated vocabulary knowledge than on the ability to retrieve and adapt functional linguistic patterns quickly and appropriately. Writing was integrated within a combined Speaking-to-Learn and Writing-to-Learn framework, where speaking and writing were treated not simply as a product to be evaluated but as a process that helped learners organise technical knowledge and reflect on their professional communication [1]. Engineers speaking and writing technical summaries in German were not only practising vocabulary and grammar, but also working out what they actually understood about the technical content itself.

2.3 Intercultural Competence, Translanguaging and Critical AI Literacy

Effective communication in German-Greek professional contexts requires intercultural competence alongside linguistic proficiency, a point strongly supported in the literature and repeatedly confirmed throughout this program in practice [7, 13, 14]. The differences between German and Greek professional communication cultures extend beyond grammar and vocabulary. Questions of directness, structure, and professional tone often influenced how technical communication was perceived [7]. For this reason, intercultural elements were regularly integrated into the lessons through workplace communication, current German topics and news, authentic materials, and discussions about regional language use and dialects. These aspects helped participants develop not only linguistic competence, but also a broader understanding of professional and cultural communication in German-speaking environments. At the foundational levels, Greek often became an important support tool within the learning process. It was used to clarify difficult grammatical structures, explain technical terminology, and discuss complex communication situations that would otherwise have remained unclear. Especially in high-pressure professional contexts, the strategic use of the learners' first language often reduced insecurity and helped participants process technical information more confidently [15, 16, 28]. This approach also reflects a broader shift away from older monolingual teaching models that viewed the first language mainly as interference. In practice, many participants were able to understand and discuss complex technical content more effectively when they could draw on both Greek and German as part of the learning process. The growing use of generative AI in professional communication gradually became relevant for the program, even though it had not originally been part of the teaching design. By 2023, several participants were already using AI tools for translation, emails, and workplace communication support. In some cases, the results were useful. In others, the generated texts sounded fluent but contained misleading technical terminology, inappropriate register, or factually incorrect information. As a result, AI-generated communication increasingly became part of classroom discussion. Participants compared AI-generated texts with authentic workplace communication, reflected on linguistic and technical differences, and discussed how experienced professionals would formulate similar content more appropriately. In this way, the growing presence of AI also reinforced the importance of authentic professional communication, professional language awareness, and critical reflection within the learning process [8, 9, 23].
Taken together, these theoretical perspectives helped shape a teaching approach that developed gradually in response to the communicative realities of the engineering workplace rather than through a strictly fixed curriculum.

3. Methodology

3.1 An Adaptive, Needs-Driven Framework

The methodology of this program was not fixed at the outset. It evolved through continuous contact with a specific professional environment and changed, sometimes quite substantially, as workplace demands changed and as I learned, occasionally through mistakes, what actually worked with this particular group [5, 11]. The foundational levels (A1 to B2) required a strong emphasis on linguistic stability through vocabulary development, grammatical consolidation, guided production, and scaffolding strategies that provided structured support which was gradually reduced as learners became more independent [19]. At this stage, Greek was used strategically as a cognitive bridge, consistent with current translanguaging

research [15, 16]. The advanced group (B2 to C1, together with two C2 participants) required a noticeably different approach focused more strongly on discourse competence: the ability to sustain extended technical explanations, structure complex arguments under pressure, and communicate clearly and professionally in demanding workplace situations rather than simply producing grammatically correct language [1, 6].

3.2 Task-Based Activities, Case-Based Learning and Writing

Task-based activities formed the methodological core of the program and included technical explanations, professional text analysis, phone-call simulations, structured oral presentations, and workplace-related writing tasks. In many cases, participants first presented technical topics in Greek before gradually transferring the content into German in more extended form, a strategy that allowed them to build on existing professional expertise instead of developing technical communication entirely from the beginning [15]. At advanced levels, podcast-style recordings were also introduced as an experimental but highly successful activity format. They required participants to produce extended monologic speech without conversational support and therefore simulated professional situations such as technical phone calls, project explanations, or solo client presentations quite closely [24, 25]. Case-based learning was, in my experience, one of the most effective methodologies at advanced levels and also one of the most demanding to prepare. Realistic engineering scenarios, including a simulation involving structural damage discovered after project completion, required participants to identify technical causes, assess professional responsibilities, formulate possible solutions, and communicate decisions to different stakeholders. These tasks could not be completed through linguistic fluency alone. They required the integration of technical judgement, professional ethics, and communicative precision, precisely the kind of integrated competence professional language education should aim to develop [20, 21]. Intercultural reflection and discussion were integrated throughout the program, not as isolated topics but as natural dimensions of the professional communication situations participants encountered in their daily work [7, 8, 9, 13, 14, 23]. Collaborative discussion and peer reflection also played an important role, particularly during simulations and case-based activities where participants evaluated different communicative strategies together. Recurring communicative patterns and professional expressions were recycled regularly throughout the lessons in order to strengthen fluency and communicative confidence.

4. Implementation

4.1 Curricular Flexibility and Authentic Materials

The implementation rested on a particular understanding of what a language classroom can be in a professional context: not a protected space separated from working life, but a space where the communicative challenges of the engineering workplace are brought in, examined, and worked through in the target language [5, 11]. Lesson content emerged from the intersection of published DaF materials and the participants' immediate professional realities, an approach that required constant adaptation but ensured that what happened in the classroom remained connected to what mattered outside it [1, 6]. Authentic documents were central throughout the program. Real reinforcement plans (Bewehrungspläne), soil reports (Bodengutachten), technical specifications, workplace emails, and project-related documents, not only textbook approximations, were used at every level, adapted in complexity for foundational learners and used as discourse models for advanced participants [17]. Case studies with historical and cultural depth, including the structural restoration of the Pergamon Museum in Berlin and bridge engineering projects, connected technical vocabulary to real engineering decisions and gave participants a broader sense of German engineering culture beyond their immediate professional context [7]. Current German topics and professional communication practices were also integrated regularly into the lessons in order to connect technical language learning with wider cultural and workplace realities. Several participants undertook work placements at the Lippstadt office during this period, and the communicative gains from those immersive experiences were often more significant than what equivalent classroom time alone could produce [6, 15].

4.2 Differentiation, Challenges and AI Literacy in Practice

The differentiation between level groups involved far more than differences in vocabulary difficulty. At the foundational levels, the main priority was building enough linguistic confidence and stability for

professional communication to develop gradually over time. This required scaffolding strategies, guided production, strategic translanguaging, and, above all, patience with the slower progress that adult learners under considerable professional pressure do not always find easy [15, 16, 19]. At advanced levels, the focus shifted more strongly toward discourse competence: sustained explanation, structured argumentation, and spontaneous professional interaction in technically demanding situations. Some participants also attended external German courses and pursued formal certifications alongside the in-company training, which often accelerated their development beyond what weekly ninety-minute sessions alone could realistically achieve. It would be misleading to present the implementation of this program as entirely smooth. Participants often arrived at lessons before or after full working days, concentration was sometimes limited, motivation changed over the course of the four years, and some participants were openly critical of aspects of the training at different points. Learning to distinguish between criticism that required genuine changes in the teaching approach and frustration that mainly required acknowledgement was one of the more demanding professional challenges this program presented for me as an educator [17, 18]. Some participants regularly used AI-supported translation and writing tools in their daily work, which occasionally influenced written tasks, emails, and classroom discussions. [8, 9, 23, 26].

5. Results

5.1 Communicative Development and Speaking Confidence

The most significant development across the four years was the gradual shift from passive understanding to more active and confident communication in German, a development that was difficult to measure formally but became increasingly visible in the way participants engaged with professional communication over time. Engineers who had initially avoided speaking German spontaneously, often preferring to communicate more carefully through writing, gradually became more willing and eventually more comfortable communicating in real-time workplace situations. This development did not follow a linear path. There were periods of visible progress, longer plateaus, and phases in which professional stress or workload noticeably affected participation and confidence. At the same time, there were also moments in which participants suddenly demonstrated communicative abilities that had clearly been developing gradually over a longer period of time [1, 6]. Systematic vocabulary recycling and the repeated use of functional expressions (Redemittel) provided participants with reliable linguistic tools for professional interaction: how to open a technical discussion or disagree in ways that German professional culture often perceives as direct rather than confrontational [22]. Participants also developed a growing awareness of how German professional writing differs from Greek or English professional communication styles [1, 7]. Speaking confidence developed most noticeably during authentic workplace-related tasks, presentations, and case-based simulations, which reflects findings from TBLT research on the relationship between authentic tasks and productive fluency [4, 24, 25].

5.2 Intercultural Awareness, AI Literacy and the Limits of Progress

Intercultural development was generally slower and more difficult to observe than linguistic progress, but its professional impact was often equally important. Over time, participants developed a growing understanding of how German professional communication and workplace culture function in practice, particularly regarding directness, structure, and professional interaction. The goal was not to imitate German communication styles completely, but to understand them well enough to navigate workplace situations more confidently and appropriately [7, 13, 14]. This development required time and continuous exposure to authentic communication situations, workplace discussions, and intercultural reflection throughout the program. In many cases, participants gradually became more aware of how small differences in phrasing, tone, or communicative structure could influence professional interactions in German-speaking work environments. The growing use of AI-supported translation and writing tools in the participants' professional environment also became increasingly visible throughout the program and occasionally influenced written tasks and emails. At the same time, the limitations of the program should also be acknowledged openly. Progress was not uniform across participants, motivation changed over time, and sustaining long-term engagement alongside demanding professional responsibilities remained challenging throughout the four-year period. In addition, the absence of formal outcome measurement remains one of the limitations of this practice-based account [17, 18].

6. Discussion and Conclusion

6.1 Authenticity, Educator Development and the Changing Role of the Language Teacher

The primary conclusion of this paper is one with important implications for language teacher education: teaching professional language effectively requires genuine engagement with the professional field itself. I do not come from an engineering background. Yet over the course of four years I read about bridge construction, worked with real Bewehrungspläne, and tried to understand the Eurocodes well enough to recognise why they matter to the people I teach. This investment, something no DaF teacher training program formally prepared me for and nobody explicitly required of me, was, in my experience, one of the main factors that transformed the program from a general language course into training that connected more directly to the participants' professional realities [6, 7, 17]. At the same time, this long-term collaboration also changed my own understanding of language teaching. Over the years, I developed a much deeper awareness of the communicative pressures, workplace realities, and professional ways of thinking that shape engineering environments. The program therefore became not only a long-term process of professional and linguistic development for the participants, but also a continuous process of professional and interdisciplinary learning for me as an educator.

The classroom that developed through this process was not simply a protected space for language practice, but increasingly a space connected to real professional communication and workplace problem-solving. Authentic documents, realistic case studies, workplace communication, and professional challenges became central parts of the learning process rather than additional illustrative material [4, 17]. In this context, authenticity was not simply a teaching strategy but an important condition for relevance and engagement. When participants worked with real reinforcement plans instead of simplified textbook examples or discussed communication situations closely connected to their daily professional reality, the relationship between language learning and professional action became more immediate, practical, and meaningful [1, 6]. The experiences described in this paper also point toward a broader shift in the role of the language educator in professional contexts. In increasingly multilingual, interdisciplinary, and AI-influenced workplaces, language teaching can no longer be separated easily from intercultural communication, workplace interaction, and profession-specific communication practices. As a result, the role of the language teacher becomes more adaptive, interdisciplinary, and more directly connected to real professional environments than traditional language teaching models often assume. In many cases, language educators increasingly act not only as teachers of grammar and vocabulary, but also as mediators between language, professional communication, and workplace culture.

6.2 Future Perspectives and Professional Outlook

Future research could examine more systematically how long-term workplace-oriented language programs influence professional communication, intercultural competence, and communicative confidence in multilingual technical environments. It may also be valuable to explore more closely how language educators themselves develop professionally through sustained engagement with highly specialised professional fields [8, 15, 18]. The experiences described in this paper suggest that workplace-oriented language teaching will likely become increasingly interdisciplinary, adaptive, and closely connected to authentic professional communication in the future. In multilingual and technologically evolving workplaces, professional language education may require stronger collaboration between language educators, subject specialists, and workplace institutions in order to respond effectively to changing communicative demands. The long-term nature of this program also highlighted the importance of continuity, trust, and sustained collaboration in adult professional language learning. Over several years, participants not only developed linguistic competence, but also greater communicative confidence, intercultural awareness, and familiarity with German-speaking professional environments. At the same time, the program continuously expanded my own understanding of workplace communication, engineering culture, and interdisciplinary language teaching practice.

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AI-supported tools were used exclusively for language correction, proofreading, and stylistic refinement during the preparation of this paper. All pedagogical observations, professional experiences, classroom examples, interpretations, and conclusions are based entirely on the author's own long-term teaching

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Linguistic Immersion and Its Role in Teaching Arabic to Non-Native Speakers: Middlebury College in the United States as a Model

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Abstract

This study explores the role of universities that teach Arabic as a second language in implementing immersion programs that extend beyond traditional curricula, classrooms, and instructors. By integrating cultural education, these programs provide learners with opportunities to engage directly with the Arabic language in authentic contexts, including social interactions, community participation, and cultural practices such as traditional clothing, customs, and celebrations. This approach emphasizes experiential learning, in which learners actively use the language in meaningful situations, fostering both linguistic proficiency and sociocultural understanding.

Moreover, language immersion encourages learners to internalize grammatical structures, vocabulary, and communicative strategies naturally while promoting motivation, autonomy, and confidence. The study also addresses challenges associated with immersion, including pronunciation, conversational skills, and language fluency, and proposes strategies to overcome these obstacles effectively. Furthermore, it highlights how situational and contextualized language experiences can complement or replace conventional textbook-based instruction, leading to more effective and lasting learning outcomes.

The findings indicate that students involved in immersion programs demonstrate higher levels of fluency, cultural awareness, and integration within Arabic-speaking communities. Finally, the study underscores the crucial role of educational institutions in designing and supporting comprehensive immersion experiences that enable learners not only to acquire language skills but also to develop a deeper understanding of the social and cultural dimensions of the Arabic-speaking world.

Keywords: *Language Immersion, Arabic as a Second Language, Cultural Integration, Experiential Learning, Fluency Development.*

Introduction

Drawing on personal experience gained while working in an Arabic language immersion program for non-native speakers at Middlebury College in the United States, this paper explores an intensive educational model designed to integrate learners fully into the Arabic language through academic coursework, daily activities, lectures, and a wide range of linguistic situations encompassing social, cultural, and psychological dimensions. In this model, language learning is transferred from the confined space of textbooks into the sphere of everyday lived experience. Consequently, the non-native Arabic learner exists entirely under the umbrella of Arabic both inside and outside the classroom—in restaurants, clubs, swimming pools, offices, holiday gatherings, evening events, and social activities within a closed university campus unified by a single linguistic and communicative context.

Linguistic immersion is regarded as one of the major branches of communicative linguistics. This field first emerged in 1947 at the University of Michigan through the work of Charles Fries and Robert Lado. Research efforts later continued in other institutions, such as University of Edinburgh in 1956 and the Center for Applied Linguistics in Washington in 1957, with the aim of defining the domains included within this specialization.

In *An Overview of Applied Linguistics* (2013), Murcia and Schmitt note that the American Association for Applied Linguistics (AAAL) identified the principal areas of this field. Applied linguistics thus became concerned with the study of language, the ways in which it is learned and used to achieve communicative goals, and the search for solutions to real-world problems. Among the most prominent topics within this field are language and technology, second-language acquisition, translation and interpretation, and linguistic immersion. This raises several important questions: What is linguistic immersion? Does it have

historical roots? What are its types and strategies? And how can it contribute to solving communicative challenges?[6]

Historically, immersion predates formal educational institutions. In earlier times, parents often sent their children to live among eloquent speakers in remote desert regions or isolated environments free from linguistic interference, where language—especially Classical Arabic—remained pure and unaffected. Ibn Khaldun discussed the concept of the "linguistic faculty" (*al-malakah al-lughawiyyah*), which individuals acquire through their environment by means of listening, communication, and repetition. He explains that a child raised among a speech community naturally acquires its language and internalizes its structures until he becomes capable of using it fluently, including its grammar and rhetorical features. Ibn Khaldun further argues that this acquisition is not primarily dependent on the direct study of grammatical rules, but rather on developing the linguistic faculty through hearing, speaking, and practical use. This is the same mechanism through which language is transmitted across generations.[7] He also states: "Languages are all faculties resembling crafts; they are faculties of the tongue for expressing meanings, and their perfection or deficiency depends upon the completeness or incompleteness of that faculty."[8]

Linguistic Immersion: Linguistic and Terminological Definitions

Arabic lexicons distinguish between the terms *ghaṭs* (diving) and *ghams* (immersion). *Lisān al-ʿArab* states: "To dive and to immerse are one and the same," and "He immersed him in water." Nevertheless, the term *immersion* carries broader and more comprehensive implications than *diving*, since immersion implies prolonged presence and continuity, whereas diving generally indicates brief submersion associated with water. Accordingly, linguistic immersion is more comprehensive than mere linguistic "diving." *Al-Muʿjam al-Wasīṭ* defines the submerged part of a ship as "the lower part that disappears beneath the water."[9]

Thus, immersion in language signifies remaining, prolonged engagement, integration, and complete involvement within something. It is therefore more precise and comprehensive than related terms.[10] Linguistic immersion rests upon two essential dimensions: the language itself and the duration of time spent engaging with it. It is a language-teaching principle based on total exposure to the target language for a specified period during which no language other than the target language is used.[11]

For this reason, many experts and specialists in teaching Arabic as a second language emphasize the necessity of allocating sufficient time for learners to achieve social immersion and psychological adaptation. Some scholars argue that instructional materials, worksheets, activities, and listening exercises should extend beyond textbook pages and become lived experiences. The target language should function as a tightly monitored medium of effective daily communication, supported by strict linguistic supervision and correction by teachers or more advanced learners. In accordance with Stephen Krashen's theories, language must be used for authentic communication in order to become firmly established in learners' minds before assignments, examinations, and assessments.

From the perspective of Abdelrahman Al-Haj Saleh, language is fundamentally a skill that develops only within its natural environment—an environment in which no sound or speech is heard except the target language. The learner must be immersed in its sounds[12] so thoroughly that nothing else is spoken or heard. This leads to the conclusion that immersion means placing the learner within an appropriate linguistic environment where only the target language is heard and spoken. Linguistic immersion enables learners to acquire accurate expression smoothly and naturally, much like foreign students learning a second language. Such immersion is considered essential for acquiring linguistic competence, as learners are prevented from hearing or speaking any language other than the one through which instruction is delivered.

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[7]See: *Muqaddimah*, edited by Abdullah Muhammad, Dar Al-Balghi – Halabouni, Al-Hidaya Library, 2004, p. 4.

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Types of Linguistic Immersion

According to Nadia Ibreikat in her study *Linguistic Immersion in Teaching Arabic to Non-Native Speakers*, immersion can be classified as follows:

A. Environmental Immersion

Natural Environment
This refers to a setting in which learners interact directly with native speakers of the target language, thereby acquiring both language and culture naturally and spontaneously, such as living with an Arab family.
Artificial or Virtual Environment
This refers to an environment deliberately designed by educational institutions through pedagogical strategies intended to immerse students in the target language community both inside and outside the classroom.

B. Age-Based Immersion

Early Immersion
Begins in kindergarten, where the mother tongue is postponed for several years while the second language is introduced as the primary medium of instruction.
Partial Early Immersion
Both the first and second languages are used as instructional tools from the beginning of schooling, as seen in countries such as Morocco where Modern Standard Arabic and French coexist in education.
Late Immersion
Occurs during secondary education, similar to the introduction of foreign languages such as English or Spanish into school curricula across many Arab countries.

C. Immersion Programs in the United States and Elsewhere

Partial Immersion Programs
Students spend only part of their time learning through the second language.
Full Immersion Programs (100%)
Learners spend all their time using and learning the second language.
Bilingual Programs
Linguistic minorities are immersed within the majority language community while one language remains the primary medium of instruction.
Two-Way Immersion
This is the most widespread model in the United States and incorporates two languages within the immersion system. However, the researcher's experience at Middlebury College demonstrated a stricter model in which students signed a "language pledge" prohibiting the use of their mother tongue (English) on campus. English use was permitted only during the first four weeks of the beginner level before students formally committed to the pledge.
Middlebury Language Schools as a Model
The summer program at Middlebury Language Schools in the United States is considered one of the most prominent models of intensive linguistic immersion. The program usually lasts between seven and eight weeks during the summer and aims to enable learners to acquire a foreign language rapidly through complete integration into a single-language environment.
The program follows an intensive system of study in which students complete the equivalent of a full academic year of language instruction within a short period of time. The curriculum includes daily classes in various language skills such as speaking, listening, reading, and writing, in addition to daily assignments and group projects. Teaching methods are also based on interaction and continuous practice through discussions, presentations, and practical activities rather than traditional instructional methods. One of the important features of some language programs, especially Arabic, is that instructors are often native speakers of the language, which provides learners with an authentic linguistic model that helps them acquire proper pronunciation and accurate language use in natural contexts. This factor enhances the quality of immersion and strengthens the cultural dimension alongside the linguistic one.
The program is also distinguished by the diversity of its students' educational motivations. Some study the language for academic purposes, such as pursuing graduate studies or conducting scientific

research, while others seek to develop their language skills for professional purposes or for careers that require proficiency in the language. Others participate out of personal or cultural interest. This diversity creates a rich educational environment characterized by interaction and the exchange of experiences.
Within this comprehensive linguistic immersion model, learning is not limited to classroom instruction; rather, it extends to every aspect of daily life on campus. This structure is designed to make the target language the primary—and almost exclusive—means of communication throughout the entire period of residence.
Among the most prominent academic activities accompanying classroom instruction is what is known as "Wednesday Talk," an informal weekly gathering organized on campus that allows students to discuss cultural and social topics in the target language within an interactive atmosphere away from the pressure of the classroom. These sessions are often attended by a well-known invited guest speaker from outside the institution. In addition, the program offers extended office hours during which instructors dedicate extra time outside official working hours to help students overcome linguistic difficulties and review written and oral assignments.
Furthermore, the program is rich in daily student and cultural activities, including artistic performances, theatrical productions, group discussions, and sports events. All of these activities are designed to be conducted in the target language so that the language becomes a means of social interaction rather than merely a tool for academic learning.
The campus environment in these programs is distinguished by being transformed into a fully integrated linguistic and cultural setting in which the target language is used in every aspect of daily life, from signs in the hallways to the names of classrooms and facilities. Even everyday spaces such as the library, classrooms, and cafeteria operate within a unified linguistic identity that reinforces complete immersion.
Another prominent cultural aspect is the organization of a weekly Arabic dinner in Arabic language programs, where students gather for a communal meal featuring traditional Arabic dishes. During these gatherings, the linguistic and cultural context is intentionally used to enhance learning. This dinner is not merely a dining activity, but rather a cultural experience that combines language, food, and social interaction in an atmosphere that reflects the authentic culture of the language being studied.
Thus, the program is transformed into a fully integrated educational and living environment in which academic study and daily life are intertwined within a single framework, making linguistic immersion a comprehensive experience that simultaneously encompasses language, culture, and social interaction.
As previously mentioned, the program also implements the principle of the "language pledge," whereby students are required to use only the target language throughout their entire period of residence, both inside and outside the classroom, including in university housing and daily activities. This contributes to the creation of a complete immersion environment that significantly accelerates the process of language acquisition.
Overall, the program provides an intensive and comprehensive educational experience that combines rigorous academic study with student life within a closed linguistic environment, making it an advanced model of effective linguistic immersion. See the table below.

Domain	Activity	Description
Academic / Interactive	Wednesday Talk	An informal weekly gathering for discussing cultural and social topics in the target language.
Academic / Educational Support	Intensive Office Hours	Additional hours provided by instructors to assist students with comprehension, revision, and error correction.
Cultural / Social	Student Activities	Discussions, artistic and theatrical performances, and cultural events conducted in the target language, including the talent show.

Sports / Recreational	Sports Activities	Activities and games designed to enhance linguistic communication in non-academic contexts.
Environmental / Linguistic	Campus Environment	Use of the target language in directional signs, facilities, and daily communication across campus.
Cultural	Arabic Dinner	A communal meal featuring traditional Arabic dishes used to enhance cultural and linguistic interaction among students.

Linguistic immersion programs also rely on a range of educational strategies aimed at supporting language learning beyond the boundaries of the classroom, whether inside or outside the university, by enabling learners to practice the language in a natural manner that helps reinforce what they have learned. Language learning is therefore not limited to the memorization of information and grammatical rules; rather, it also includes the practical application of speaking, writing, and communicating with others, thereby providing learners with authentic and diverse linguistic opportunities.

Among the most important of these strategies is the repetition and review of lessons, through which foreign learners are given multiple opportunities to revisit what they have learned in a natural and systematic way. This process enhances their understanding of linguistic information and grammatical structures while developing their ability to use them effectively in different communicative situations. In addition, dialogue-based instruction is considered one of the most effective strategies in this context. Dialogue is not merely a means of communication between two individuals; rather, it is regarded as an educational tool that goes beyond the exchange of speech to include the acquisition of linguistic, social, and cultural values and skills associated with communicative interaction.

Immersion programs in educational institutions have also adopted a range of practical strategies to achieve their objectives. One of the most important of these is the linguistic and cultural partner strategy, which represents an immersion component in programs that do not follow a fully intensive model. This strategy is based on employing native speakers of the language—usually university students—as companions for learners. The linguistic partner accompanies the learner outside official class hours and communicates with them exclusively in Arabic, thereby creating a natural communicative environment that enables the learner to practice the language continuously and develop the ability to use it fluently in everyday life situations.

According to the description provided by Middlebury Language Schools of its intensive summer program, assessment and testing constitute an essential component of the linguistic immersion experience. The evaluation process is conducted through several interconnected stages: the placement test upon admission, weekly assessments, and finally the exit examination.

At the beginning of the program, students undergo placement tests designed to determine their linguistic proficiency accurately upon arrival. These tests usually assess multiple skills such as reading, writing, and listening, in addition to oral interviews that evaluate students' speaking abilities and communicative interaction. The results of these assessments are used to place each student in the appropriate academic level within the program, ensuring that the learning process remains balanced and effective from the very first day.

During the summer session, however, assessment is not limited to traditional examinations. Rather, the program relies on continuous weekly oral tests and evaluations. Students are assessed regularly through class participation, their ability to engage in dialogue, oral presentations, discussions, and daily assignments. This system is intended to ensure the continuous use of the language within the immersion environment, rather than restricting language use to formal examinations alone.

At the end of the program, students undertake a final exit assessment aimed at measuring the extent of the linguistic progress they have achieved during the immersion period. This evaluation typically includes fluency in speaking, listening comprehension, and the ability to express oneself both orally and in writing. Furthermore, students' final proficiency levels are compared with their initial placement results in order to measure the amount of progress achieved throughout the summer program.

Overall, the assessment system at Middlebury College is based on a fundamental principle: language is not merely tested, but practiced on a daily basis. Consequently, examinations are integrated into the

broader immersion experience, which combines learning with continuous application throughout university life.
In this regard, Addison argues that immersion is important for distinguishing between different social communities, meaning that the application of immersion helps differentiate societies and their respective languages. He also emphasizes the importance of social language and the necessity of understanding it, stating: "The facts of language can deepen one's understanding of society, just as it is difficult to find characteristics that distinguish a society as clearly as its language does."[13]
This means that understanding the nature of language and its unique foundations within each society contributes to a deeper understanding of that society itself, since every community is distinguished by its own language, which reflects its identity and culture. Accordingly, linguistic immersion is considered one of the most effective methods of language acquisition because of its important role in creating a sound linguistic environment capable of developing learners' Arabic language skills.
In other words, immersion creates a healthy linguistic atmosphere that contributes to the development of learners' Arabic abilities, whether in pronunciation, accent, or even the use of Modern Standard Arabic. Students at Middlebury College in the United States, for example, are exposed to a wide range of pronunciation styles and accents due to the diversity of national backgrounds among their instructors, all of whom are native speakers of Arabic.
Furthermore, Jibril Bouzouina[14] discusses in his article the importance of linguistic immersion in teaching both second languages and even the mother tongue. According to him, immersion achieves the following:

- It accelerates the learning and teaching of a second language within a short period of time and with high efficiency.
- It enriches the various skills of second-language learners.
- It enables learners to connect what they hear and learn with their own personal experiences, thereby increasing their self-confidence.

Mechanisms of Linguistic Immersion and the Role of the Teacher

The mechanisms of linguistic immersion are based on a set of fundamental principles that ensure language acquisition occurs naturally and effectively. Among the most important of these principles are listening, repetition, and practice. Continuous exposure to the language in its natural contexts enables learners to become familiar with its sounds and structures and to internalize them spontaneously. Repetition, on the other hand, contributes to reinforcing these linguistic inputs in memory and strengthening the learner's ability to recall and use them correctly. Practice represents the applied dimension that allows learners to employ what they have heard and repeated in authentic communicative situations, thereby enhancing linguistic fluency and making language acquisition more stable and effective.
According to the researcher Nadia Ibreikat, the teacher's role is central to establishing the foundations of linguistic immersion, as the teacher contributes significantly to the learning of vocabulary, grammatical structures, and phonetic features. The teacher is regarded as the primary instrument in refining the learner's motor, social, psychological, and linguistic skills. Therefore, teachers are required to possess specific competencies that enhance the learner's ability to use Modern Standard Arabic accurately and effectively.

1. Articulation and Pronunciation of Sounds
The teacher must possess accurate pronunciation and should give each sound its proper value. A speaker cannot produce sounds correctly unless they possess a healthy and proper speech apparatus. It is therefore essential for the teacher to be free from speech disorders and to demonstrate correct pronunciation.

2. Clarity and Projection of Voice
Clarity of voice refers to the distinctness of pronunciation, and the teacher must be able to control the volume of their voice in order to facilitate comprehension. Clear speech enhances students' ability to

[13]Addison, *Sociolinguistics*, translated by Mahmoud Abbad, 2nd ed., Cairo: Alam Al-Kutub, 1990, p. 16.
[14]Patsy Lightbown and Nina Spada, *How Languages Are Learned*, translated by Ali Ahmad Shaaban, 1st ed., Giza, 2014, p. 63.

hear and understand the linguistic content being presented, thereby increasing their effectiveness in comprehending linguistic concepts.

3. Calmness and Deliberation in Speech

Calmness and deliberation in pronunciation refer to speaking slowly and avoiding rushing through sounds and words, which helps learners understand what they hear. This also highlights the importance of giving listeners sufficient time to absorb information. As one scholar stated: “In his speech, he does not allow the listener enough time to understand what is being heard… thus boredom overtakes the listener, who eventually stops paying attention.” This indicates that brief pauses are important in enabling learners to comprehend and interact with the material being presented.

4. The Ability to Modulate Vocal Intonation

The ability to modulate vocal intonation refers to controlling the tone of voice during speech according to different expressive modes, thereby helping listeners understand the meanings and intentions conveyed in sentences. As Zalmad Abu Zira explains: “The interrogative sentence differs in its intonation from the imperative sentence, and this in turn differs from the tone of a sentence expressing hope.”

Accordingly, teachers must pronounce every sentence correctly, including the tones associated with questions, exclamations, and other forms of expression, so that learners are able to understand the tonal distinctions that contribute to the clarity of meaning. Therefore, successful teachers should vary their teaching methods by altering the delivery of their voice, changing their gestures and movements, and varying vocal intonation in order to maintain students’ attention, stimulate their interest, and sustain their concentration while explaining linguistic material that requires familiarity with the sciences of language.

For this reason, teachers should diversify the tones of their voice during instruction so that learners do not lose focus on the intended objectives and purposes of the lesson. Teachers must therefore possess competencies in both receptive and productive language skills.

Conclusion

In conclusion, linguistic immersion is considered one of the most successful approaches to teaching Arabic to non-native speakers because it enables learners to move genuinely from theoretical learning to practical application within integrated real-life contexts. The experience of Middlebury College has confirmed the success of this model, as it succeeded in achieving remarkable linguistic progress among students within a relatively short period due to the intensive linguistic environment and continuous interaction.

This experience has also highlighted the importance of fully immersing learners in the target language through temporarily disconnecting them from their mother tongue and relying on the second language as the sole means of communication and thought. This approach contributes significantly to accelerating language acquisition, enhancing fluency, and building self-confidence, free from mental translation and dependence on the first language.

Accordingly, the success of this model emphasizes the necessity of adopting linguistic immersion programs in the teaching of Arabic, while focusing on creating a closed linguistic environment that supports the continuous use of the language. Such an environment contributes to achieving authentic and profound acquisition of the Arabic language among learners.

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Popular Culture in the Age of Artificial Intelligence: An Applied Study on the Arabic Language

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Abstract

This study aims to explore the challenges of translating popular culture (pop culture) in the context of artificial intelligence applications, through an applied study on the Arabic language. The research is grounded in the assumption that popular culture represents one of the most complex domains of translation, as it relies on deep semantic, cultural, and contextual layers that extend beyond the literal meaning of texts. With the increasing reliance on AI-powered translation systems, there is a growing need to assess their ability to handle such complexities effectively. The study adopts a descriptive-analytical approach, selecting a corpus of texts representative of popular culture, including film dialogues, youth expressions, songs, and digital content. These texts are processed through AI translation tools, and the outputs are systematically analyzed and compared with their original meanings within their cultural contexts. The analysis focuses on a proposed classification of errors, including semantic, cultural, contextual, pragmatic, and stylistic errors. The findings indicate that AI systems demonstrate considerable efficiency in translating direct and literal structures; however, they show clear limitations in handling figurative language, implicit cultural references, and idiomatic expressions. This often results in literal or misleading translations that fail to convey the intended meaning and diminish the cultural essence of the source text. Moreover, these systems lack sufficient awareness of the social and cultural context, which is essential for interpreting popular culture accurately. Beyond identifying these challenges, the study proposes utilizing AI-generated errors as a pedagogical tool in translation education. By training students to critically analyze such errors, learners can develop a deeper understanding of the distinction between surface meaning and intended meaning. The study also introduces an analytical framework that may contribute to improving translation curricula in the Arab educational context and enhance learners' critical engagement with technological outputs. The study concludes that, despite its advancements, artificial intelligence cannot replace the human translator in conveying cultural meaning.

Keywords: *Popular Culture Translation, Artificial Intelligence, Machine Translation, Error Analysis, Arabic Language*.

1. Introduction of Research

Artificial intelligence technology has witnessed rapid advancement in recent years especially in the field of natural language processing which has directly contributed to improving the performance of machine translation systems [1]. These systems based on deep learning and Neural Machine Translation (NMT) models have brought a qualitative shift in terms of translation accuracy and fluency when compared with old systems [16]. As a result, the use of these technologies has expanded across many domains such as media and education and digital communication [3]. However, despite the significant progress of this technology it does not resolve the challenges associated with these systems ability to capture context and understand the deeper meanings of texts as we see in recent literature [11].

At its core translation is more than just direct transfer of language because it is closely connected to the cultural and social context where the text is produced [10]. Meanings cannot be fully understood away from the cultural frameworks that shape them which makes the achievement of equivalence in translation depends on the ability to represent cultural and pragmatic dimensions alongside the linguistic dimension [2]. Recent studies indicate that machine translation systems despite their remarkable development still face significant limitations when dealing with these dimensions especially in texts characterized by high degree of cultural density [8].

Popular culture is considered one of the clearest domains in which these challenges become evident due to its distinctive linguistic and cultural features [1]. It relies heavily on informal expressions and colloquial terminology and implicit references that appear in film dialogues songs and circulating digital content [8]. Such texts involve multiple layers of meaning including figurative language and idiomatic expressions which are difficult to render directly into another language without losing part of their significance [10]. Studies have shown that machine translation systems tend in such cases to produce literal translations which leads to a decline in the transfer of the intended cultural meaning [2].
Despite the notable progress achieved by AI-based translation systems they still encounter clear difficulties when handling texts characterized by complex cultural content particularly texts related to popular culture [16]. While these systems show acceptable efficiency in translating direct structures, they often fail to represent implicit meanings and the cultural contexts associated with the text [11]. As a consequence, they may generate translations that appear linguistically correct but lack accuracy at the semantic and cultural levels which ultimately affects the quality of the translation and its communicative function [3].
In this context a review of the literature shows that most recent studies in machine translation have focused either on the overall performance of models or on formal and standardized texts whereas studies addressing the translation of popular culture remain limited especially within the Arab context [10]. It is also noticeable that there is a lack of studies adopting a systematic multidimensional analysis of translation errors one that encompasses semantic, cultural, contextual, and pragmatic aspects [16]. Hence there is a pressing need for applied studies that address this gap through an in-depth analysis of machine translation outputs in this type of text [8].
Accordingly, this study aims to analyze the performance of AI-based translation systems in translating popular culture texts into Arabic through an applied error-analysis approach [2]. It also seeks to construct an analytical framework for classifying these errors according to multiple dimensions including semantic, cultural, contextual, pragmatic, and stylistic aspects in addition to exploring the potential use of such errors in developing translation teaching skills [1]. The significance of this study lies in its contribution to deepening critical understanding of machine translation applications and supporting the development of related educational and practical practices within the Arab context [11].

1.1 Research Problems

Despite the rapid advancements witnessed in artificial intelligence–based translation systems particularly with the adoption of neural machine translation models their ability to effectively handle texts characterized by complex cultural dimensions remains highly questionable [17]. Empirical observations indicate that while these systems show notable performance in processing direct linguistic structures their effectiveness declines significantly when confronted with texts that contain implicit meanings or non-explicit cultural and contextual references [15]. This limitation negatively impacts both the overall quality of translation and its functional accuracy [14].
This issue becomes particularly pronounced in the domain of popular culture texts which are inherently characterized by high symbolic density and a strong reliance on idiomatic expressions figurative language and context-specific social references [5]. Translating such texts requires an advanced level of interpretive competence that extends beyond surface-level linguistic processing [4]. Within this context the present research problem lies in investigating the extent to which AI-based translation systems are capable of conveying semantic cultural, and contextual, dimensions when translating popular culture texts into Arabic [17]. It also seeks to identify the types of errors resulting from these limitations and to analyze them within a systematic analytical framework that enables a precise and theoretically grounded interpretation [5].
The linguistic gap between Arabic and English makes this problem more complex because Arabic is characterized by rich morphology and complex syntax and many dialects [14]. For example, the distinction between Modern Standard Arabic (MSA) and regional dialects like the Egyptian or Saudi dialect poses a big challenge for automated systems [4]. The systems are often trained on formal texts like news or official documents, but popular culture uses everyday language that is very different [15].

Table 1. AI Translation Challenges in Popular Culture

Feature of Popular Culture	Challenge for AI Translation	Source Reference
Slang and Youth Language	Literal translation leads to loss of nuance	[1]
Idiomatic Expressions	AI cannot find cultural equivalents	[7]
Dialectal Variation	Systems trained on MSA fail in local dialects	[15]
Implicit Emotional Meaning	AI processes text as isolated units	[1]
Pragmatic Tone	Failure to convey surprise or irony	[1]
Social Politeness	Flattening levels of respect and formality	[19]

The data suggest that even advanced models such as ChatGPT and Google Translate struggle to preserve the cultural meaning of the source text [14]. As a result, students may receive translations that appear linguistically accurate but remain semantically inadequate.

1.2 Research Questions

RQ1. To what extent are AI-based translation systems capable of translating popular culture texts into Arabic with semantic, cultural, and contextual adequacy?
RQ1.1. What are the most prominent types of errors that occur in translating popular culture texts using AI-based translation systems?
RQ1.2. To what extent do these systems succeed in conveying implicit meanings and culture-specific references embedded in the source texts?
RQ1.3. How effectively do AI-based translation systems handle figurative language and idiomatic expressions commonly found in popular culture?
RQ1.4. Does translation accuracy vary according to the type of popular culture text, such as film dialogues, song lyrics, youth slang, and digital content?
RQ1.5. What are the limitations of AI-based translation systems in representing the social and cultural context of texts?
RQ1.6. How can errors produced by AI-based translation systems be utilized to enhance translation pedagogy and foster learners' critical awareness?

1.3 Research Objectives

The study intended to achieve the following specific objectives: first to analyze the performance of AI-based translation systems in translating popular culture texts into Arabic [18]. Second to identify the most common error patterns in machine translation outputs particularly semantic cultural, contextual, pragmatic, and stylistic errors [12]. Third to examine the extent to which these systems can convey implicit meanings and culture-specific references embedded in the source texts [13]. The fourth objective is to develop a systematic analytical framework for classifying translation errors in popular culture texts [7]. And fifth to explore the popular potential of using AI-generated translation errors as a pedagogical tool for enhancing translation teaching and promoting learners' critical awareness [9].

1.4 Significance of the Study

This study has both theoretical and practical significance. From a theoretical side it contributes to advancing the scholarly understanding of artificial intelligence applications in translation particularly in relation to the translation of culturally complex texts [6]. It addresses a notable research gap reflected in the limited number of applied studies examining the translation of popular culture within the Arab context [18]. It also proposes a systematic analytical framework for classifying machine translation errors across multiple dimensions including semantic cultural, contextual, pragmatic, and stylistic aspects [12]. From a practical side the study contributes to the development of translation pedagogy by using machine translation errors as a practical entry point for training and analytical practice [7]. It assists translation students in developing critical thinking skills and in distinguishing between literal meaning and intended meaning in culturally embedded texts [9]. It also provides practical insights that can inform developers of translation systems in improving performance particularly in handling culturally loaded texts [13].

Finally, it supports the development of translation curricula in alignment with recent technological advancements [18].

2. Theoretical Framework

This study adopts a multidimensional error lens informed by recent machine-translation quality research and translation theory: critically classifiable MT failures [14] are read alongside interference-driven production patterns in Arabic–English bilingual writing [15], while core equivalence and cultural–pragmatic arguments follow contemporary translation-studies overviews [13] [12].
Machine translation is considered one of the most prominent applications of artificial intelligence in the field of computational linguistics as it enables the automated processing and transformation of texts across languages based on advanced computational models [13]. Recent studies indicate that these systems are no longer limited to literal translation; rather they have evolved to incorporate deeper processing of linguistic structures particularly with the integration of deep learning techniques which has significantly enhanced the quality and accuracy of translation outputs [10]. This trend also suggests that machine translation has become an effective tool in supporting the use of the Arabic language in academic and scientific contexts by facilitating access to knowledge and enabling its transfer across languages [12]. However, the technological progress does not eliminate the challenges associated with the nature of the Arabic language itself which is characterized by rich morphology and contextual variability [11]. These features can negatively affect translation accuracy in certain cases especially when dealing with non-standard texts or those embedded with cultural nuances [8].

2.1 Artificial Intelligence and Machine Translation

Machine translation represents one of the key applied branches of artificial intelligence within the field of natural language processing (NLP) as it aims to automatically convert texts across different languages using computational models capable of analyzing and representing linguistic structures [6]. Recent studies indicate that this field has undergone a significant transformation evolving from rule-based models to statistical approaches and subsequently to neural models driven by deep learning [9]. This progression has substantially enhanced translation quality in terms of accuracy and fluency particularly in texts with relatively straightforward structures [7].
Modern machine translation systems rely on advanced neural architectures based on the Encoder–Decoder framework which enables context-sensitive modeling of relationships between words within a sentence rather than relying on traditional word-for-word translation [2]. The Transformer model which relies exclusively on the attention mechanism has played a pivotal role in advancing machine translation systems and improving their performance across a wide range of linguistic tasks [9].
This mathematical foundation allows the model to calculate which parts of the sentence to focus on [7]. But even with this advanced math the accuracy tends to decline in languages with complex morphological structures such as Arabic [16]. The gap between Modern Standard Arabic and regional dialects poses an additional challenge for translation systems as it requires the ability to adapt to diverse linguistic and sociocultural contexts [18].

2.2 Popular Culture and Its Translation Challenges

Popular culture represents one of the most complex domains in the field of translation as it relies on intertwined linguistic and cultural elements that extend beyond the literal meaning of the text [1]. It encompasses idiomatic expressions culture-specific references and communicative patterns embedded within particular social contexts making its transfer into another language a process that requires a deep understanding of implicit meaning rather than merely surface-level linguistic structures [6].
Within the context of machine translation these challenges become even more pronounced. Intelligent systems primarily rely on the analysis of linguistic patterns without possessing genuine awareness of the cultural context which often results in literal translations that fail to convey the intended meaning. Recent studies have demonstrated that machine translation systems encounter considerable difficulties in translating dialogues and context-dependent linguistic interactions particularly when they involve communicative acts or implicit meanings.
Furthermore, translation between Arabic and English presents additional challenges due to structural and semantic differences between the two languages especially in complex constructions such as descriptive clauses and syntactic relations. For example, the Arabic language has fewer consonant

clusters and sounds like "p" or "v" don't exist. This makes students and sometimes older AI systems spell things like "bizza" or "baber" instead of "pizza" or "paper".

2.3 Translating Popular Culture in the Age of Artificial Intelligence

The translation of popular culture is closely linked to the nature of language used in everyday contexts as such texts incorporate idiomatic expressions implicit references and communicative patterns shaped within specific social and cultural environments. Several studies indicate that despite their advancements automated systems continue to struggle with capturing these dimensions particularly when translating dialogues or texts that involve communicative acts with indirect meanings.
Recent research has shown that AI-based translation systems achieve relatively acceptable performance when handling straightforward linguistic structures however they show clear limitations when dealing with texts that contain cultural elements or implicit meanings. Evidence suggests that these systems tend to produce literal translations in such cases leading to a loss or distortion of the intended meaning.
Moreover, the challenges extend beyond the cultural dimension to include structural differences between languages. Variations in syntactic and semantic structures between Arabic and English significantly affect the quality of machine translation. For instance, the "run-on" sentence is very common in Arabic writing where students use many commas and few periods. AI often follows this pattern or fails to correct it leading to confusing output.

3. Previous Studies

Study	Focus	Main Contribution
O'Brien (2022)	Professional MT	Discussed post-editing
Rico & González Pastor (2022)	Translation Education	Emphasized MT literacy
Sun et al. (2022)	Document-level NMT	Improved contextual processing
Barrault et al. (2023)	Multilingual MT	Highlighted limitations in informal language
Nagi (2023)	Arabic-English MT	Identified structural weaknesses
Qassem & Aldaheri (2023)	Dialogue Acts	Examined pragmatic transfer
Appicharla et al. (2025)	Context-aware MT	Reviewed LLM-based translation

4. Critical Review of Previous Studies

Despite the valuable contributions most of these studies have focused on general aspects of translation quality or on isolated dimensions examined independently. They have largely failed to provide a comprehensive treatment of texts characterized by complex cultural dimensions especially in relation to popular culture within the Arab context. Hence there is a big need for an analytical framework that captures semantic cultural, contextual, pragmatic, and stylistic dimensions of translation errors in popular culture texts.

5. Methodology

This study adopts a descriptive-analytical approach with an applied orientation. This approach aims to identify patterns of errors that emerge in the translation of popular culture texts and to analyze them across multiple dimensions including semantic cultural, contextual, pragmatic, and stylistic aspects.
The study corpus consists of a purposively selected sample of 150 popular culture texts categorized into four main types: 40 film dialogues, 40 common youth slang expressions, 30 song lyrics, and 40 digital content social media texts.
The study utilizes two primary tools: AI-based translation tools Google Translate and ChatGPT. All texts were processed using standard user-level access without prompt engineering. A customized analytical model was developed for classifying translation errors into five main dimensions: semantic cultural, contextual, pragmatic, and stylistic.

6. Data Analysis

This section represents the practical component of the study where the outputs of AI-based translation systems are analyzed in their handling of popular culture texts.

Table 2. Analysis of AI-Based Translation Outputs

No.	Source Text	Machine Translation	More Accurate Translation	Error Type	Brief Analysis
1	"I'm not okay, but I'll pretend I am"	"I am not okay, but I will pretend that I am"	"I am not okay, but I am hiding it"	Pragmatic + Semantic	Failure to convey the implicit emotional meaning [1]
2	He's low-key jealous	He is low-key jealous (literal)	He is subtly jealous	Cultural + Semantic	Literal rendering of a slang expression [15]
3	That's not my vibe	That is not my vibration	That does not suit me	Cultural + Pragmatic	Failure to interpret the cultural expression [1]
4	"You really went there, huh?"	You really went there	Really? Did you actually say that?	Pragmatic + Contextual	Inability to convey the intended tone [1]
5	I just need a break from everything	I need a break from everything	I need to step away for a while	Semantic + Emotional	Loss of the emotional dimension [1]
6	This situation is eating me alive	This situation is eating me alive	This situation is emotionally draining me	Figurative + Semantic	Failure to interpret figurative meaning [7]

The findings reveal a clear gap between the linguistic proficiency of AI systems and their ability to adequately represent cultural and pragmatic dimensions. The findings align with recent studies emphasizing the limitations of NMT in culturally dense texts.

Table 3. Translation Quality Evaluation Matrix

Analytical Dimension	Performance Level	Interpretation
Semantic Accuracy	Moderate	Systems show acceptable accuracy in straightforward structures [1]
Cultural Dimension	Weak	Clear limitations in interpreting culturally embedded expressions [9]
Contextual Dimension	Moderate	Limited ability to fully capture the broader context [1]
Pragmatic Dimension	Weak	Inadequate transfer of communicative intent and tone [18]
Stylistic Dimension	Moderate	Linguistically correct but lacks naturalness [1]

7. Discussion of Results

The results indicate that AI-based machine translation systems achieve acceptable performance when processing texts that are structurally simple. However, this performance declines significantly when dealing with texts that involve implicit meanings or cultural dimensions. This suggests a systematic limitation rather than isolated translation errors. Similarly, the systems lack the ability to interpret psychological and emotional dimensions as they tend to reproduce surface meaning without capturing the affective context. In our analysis a clear deficiency is observed in the pragmatic dimension where the translation fails to convey communicative tone despite being grammatically accurate.

7.1 Ethical Use of AI Tools in Academic Writing and Translation

Students and researchers should follow institutional integrity rules when they use AI drafting or translation assistance: disclose assistance where required, keep human oversight over claims and citations, and treat detector scores as imperfect signals rather than proof of authorship [20]. Recent work also stresses AI literacy and awareness of bias when generative tools shape academic reading and writing practices [22].

Table 5. Common AI Flags

AI Overused Word	Human Alternative	Why automated writing checkers may flag it	Source
Delve	Explore / Dig into	Extremely high statistical choice for ChatGPT	[22]
Moreover	Also / Plus	Robotic formal transition	[20]
In conclusion	So / Finally	Predictable structure marker	[22]
Leverage	Use	Business jargon AI loves	[20]
Foster	Help / Grow	Common AI verb for collaboration	[20]

8. Recommendations

Based on the findings the study proposes several recommendations:
AI models should be developed to incorporate cultural and pragmatic context particularly for idiomatic and figurative expressions.
Translation systems should be trained on contemporary and informal data like social media content to better process youth language.
Mechanisms for capturing implicit and emotional meaning should be integrated into the models.
Post-editing tools should be developed to support human translators with focus on cultural and pragmatic errors.
Machine translation errors should be used as a pedagogical tool in translation education to help students distinguish between surface and intended meaning.

9. Conclusion

This study analyzed the performance of AI-based translation systems in translating popular culture texts into Arabic through a multidimensional error analysis. The findings show that while these systems achieve acceptable accuracy in structurally simple expressions their performance declines significantly when dealing with complex cultural, contextual, and pragmatic dimensions. Applied analysis shows that machine translation systems tend to rely on literal translation especially in idioms and youth-oriented discourse leading to loss or distortion of meaning. Also, the findings reveal a limited capacity to represent implicit meanings and communicative tone which affects the functional quality of translation.
The study confirms that the primary challenge in AI translation is the ability to interpret meaning within its broader cultural and social context. Development of more advanced models capable of capturing deeper layers of meaning is essential but the role of the human translator remains indispensable.

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Motivational Factors Affecting ELT Students' Use of ChatGPT Learning Outcomes in Preparing for Writing Tasks: A Mixed-Methods Study

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Abstract

The rapid rise of large language models such as ChatGPT is altering the landscape of English language education, influencing how learners approach writing, speaking, reading, and vocabulary work. Despite this shift, little is known about how English Language Teaching (ELT) majors—who must balance their roles as students and future educators—engage with these tools across different skill areas. To address this gap, the present study adopts a mixed-methods design to explore what motivates ELT students to use ChatGPT, drawing on a broad theoretical base that includes Technology Acceptance Model (TAM), the Unified Theory of Acceptance and Use of Technology (UTAUT), the Hedonic Motivation System Adoption Model (HMSAM), Self-Determination Theory (SDT), Flow Theory, and Cognitive Load Theory (CLT).The quantitative phase involved 100 randomly selected ELT students studying in the Turkish Republic of Northern Cyprus, who were invited through proportionate stratified random sampling across nine universities, while qualitative insights were gathered from interviews with 12 students recruited through purposive sampling. The findings indicate that intrinsic motivation, perceived usefulness, hedonic appeal, and ease of use strongly shape students' intentions to work with ChatGPT. Writing stood out as the skill that students found most intrinsically and hedonically engaging, particularly because the tool helped reduce anxiety and support idea development. Speaking-related motivation was tied largely to affective benefits such as increased confidence and reduced communication apprehension. In contrast, reading and vocabulary use were driven more by practical, efficiency-oriented considerations. Interview data also revealed persistent ethical concerns, including plagiarism, over-dependence, and fairness in assessment, alongside professional-identity-driven reflections on the pedagogy and assessment. Overall, the study underscores the importance of strengthening AI literacy, establishing ethical guidelines, and rethinking assessment practices within ELT programs. It contributes a skill-specific, theoretically grounded perspective on how future English teachers navigate AI-mediated learning environments.

Keywords: *ChatGPT in ELT; Learner Motivation; Technology Acceptance; Language Skills; AI Literacy; Ethical Concerns*

1. Introduction

Artificial Intelligence (AI) has rapidly reshaped language education, with large language models (LLMs) such as ChatGPT now central to how learners write, speak, read, and build vocabulary. Unlike earlier rule-based Computer Assisted Language Learning (CALL) tools, ChatGPT generates contextually appropriate, human-like responses, enabling co-constructed texts and immediate feedback. This shift from static to dynamic interaction has renewed interest in how learners—especially future teachers—adopt and assess AI-mediated learning environments.

ChatGPT is widely used in EFL/ELT writing for idea generation, reducing anxiety, and supporting revision (Teng & Huang, 2023; Xu & Jumaat, 2024; Lee et al., 2025). It also supports speaking by lowering anxiety and increasing confidence (Carrera Nuñez et al., 2025; Celik et al., 2025). However, concerns persist regarding plagiarism, overreliance, and the erosion of critical thinking (Tüm, 2026).

This study addresses these gaps by examining ELT students' motivations for using ChatGPT in writing, speaking, reading, and vocabulary tasks through an integrated theoretical framework (Technology Acceptance Model [TAM, Davis, 1989], Unified Theory of Acceptance and Use of Technology [UTAUT, Venkatesh et al., 2003)], the Hedonic-Motivation System Adoption Model [HMSAM, Lowry et al., 2013], Self-determination theory [SDT, Deci & Ryan, 1985], Flow Theory [Csikszentmihalyi, 1975,1990]and Cognitive Load Theory [CLT, Sweller, 1988]). The study contributes a skills-specific, theoretically grounded understanding of how future English teachers navigate AI-mediated learning environments

and highlights the need for AI literacy, ethical guidelines, and pedagogically aligned integration strategies.

2. Literature Review

2.1 ChatGPT in Language Teaching

ChatGPT has transformed CALL by enabling open-ended interaction, co-construction of texts, and immediate feedback. Its use in EFL/ELT spans writing, speaking, vocabulary, reading, and academic support. Despite rapid uptake, motivational dynamics—especially among ELT majors with dual learner/teacher identities—remain underexplored.

2.2 ChatGPT and EFL Writing: Process Support, Student Strategies, and Motivational Patterns

Writing is the skill that has been most heavily researched in relation to ChatGPT. Teng and Huang (2025) found that ChatGPT enhances engagement, supports idea generation, reduces anxiety during writing, and increases willingness to revise (pp.12–14), which highlights ChatGPT's cognitive and emotional benefits. Similarly, Xu and Jumaat (2024) identified improvements in aspects of linguistic quality, coherence, and efficiency but they also warn against overreliance (p.110).
According to Lee et al. (2025), students use ChatGPT for vocabulary, structure, and rhetorical structure; they value its speed and availability and often perceive it as more responsive than instructor comments, but remain cautious about accuracy and ethics (pp.3-4). ChatGPT can also scaffold novice writers by providing examples, explaining grammar, and modelling academic discourse, as Ibrahim and Kirkpatrick (2024) argued. They stressed, though, that any such integration needs to be paired with explicit instruction regarding critical evaluation and ethical use (p.405).
Tüm (2026) highlighted that AI-generated essays challenge assessment validity and fairness. Issues of authorship, academic integrity and undistinguished ability from students writing raise concerns about traditional assessment systems (p.67).
Across studies such as Teng and Huang (2025), Xu and Jumaat (2024), Lee et al. (20025), and Ibrahim and Kirkpatric (2024), several writing-related motivational patterns consistently emerge:
Intrinsic: enjoyment, curiosity, reduced anxiety
Extrinsic: efficiency, improved grades, clarity
Technological: ease of use, responsiveness
Professional (ELT students): pedagogical curiosity and future teaching relevance
They align with TAM (usefulness, ease of use), HMSAM (enjoyment, immersion) and SDT (autonomy, competence).

2.3 Motivation and Technology Acceptance

Intrinsic motivation and perceived usefulness strongly predict ChatGPT use (Lai et al., 2023). Hedonic motivation and system responsiveness influence initial adoption (Alkfairy, 2024), while meta-analytic evidence shows positive effects on learning performance and satisfaction (Wang & Fan, 2025). Enjoyment and immersion are strong predictors of continued use (Wang et al., 2025). Motivation is shaped by intrinsic enjoyment, extrinsic efficiency, hedonic pleasure, and cognitive load reduction.

2.4 ELT Students, AI Literacy, and Professional Identity

Preservice teachers recognize AI's pedagogical potential but express concerns about ethics, assessment, and identity (Guan et al., 2025). They often lack foundational AI knowledge and exhibit high trust in AI outputs. Teachers appreciate AI's potential for differentiation and feedback but worry about overreliance and fairness (Üretmen K. & Doğan, 2025). Bibliometric analyses show rapid growth in AI-related teacher-education research but highlight conceptual fragmentation and limited focus on AI literacy and ethics (Kuzu, 2025).

2.5 Theoretical Framework

Technology Acceptance Model (TAM): This model explains why and how people adopt new technologies focusing on two factors: perceived usefulness and ease of use predict intention (Davis 1989; Lai et al., 2023).

UTAUT and UTAUT2: This model explains how we use and adopt technology and identifies four key factors: performance expectancy, effort expectancy, social influence, and facilitating conditions (Guan et al., 2025; Kuzu, 2025).
Hedonic Motivation System Adoption Model (HMSAM): This model explains how people adopt technologies primarily for enjoyment, curiosity, focused immersion and perceived control (Lowry, et al.,2013; Wang et al., 2025), deep engagement (Guan et al, 2025).
Self-Determination Theory (SDT): This theory explains human motivation based on three innate psychological needs: autonomy, competence, and relatedness (Deci & Ryan, 1985).
Flow Theory: This theory describes a psychological state of complete immersion, focus, and enjoyment in an activity and claims that deep engagement arises from balanced challenge and skill (Csikszentmihalyi, 1975,1990).
Cognitive Load Theory (CLT): This theory explains how limitations of human working memory affect learning and problem-solving. It emphasizes designing instructional materials that reduce unnecessary mental effort so that learners can focus on understanding and retaining information. ChatGPT reduces extraneous load but may reduce germane load when being overused (Sweller, 1988; Sweller et al., 2011).

Summary Of Gaps

Population Gap: limited research on ELT majors' dual identities (Guan et al., 2025)
Skill-Specific Motivation Gap: few studies compare motivation across writing, speaking, reading, and vocabulary (Guan et al., 2025)
Theoretical Integration Gap: frameworks rarely unified (Kuzu, 2025; Guan et al., 2025)
Teacher Education Gap: limited research on AI literacy, ethics and assessment (Guan et al., 2025; Kuzu 2025; Üretmen K. & Doğan, 2025)

3. Methodology

3.1 Research Design

This study employed a sequential explanatory mixed-methods design in which quantitative data were collected first and qualitative data were subsequently used to elaborate and explain the survey results. The design was selected because motivation toward AI-mediated learning is inherently multidimensional, involving cognitive, affective, technological, and professional factors that can be fully captured only through a mixed-methods approach. The quantitative phase identified statistical trends related to motivation, technology acceptance, and skill-specific engagement with ChatGPT in writing, speaking, reading, and vocabulary, while the qualitative phase provided deeper insights into learners' beliefs, ethical concerns, and pedagogical reasoning, thereby offering a more nuanced interpretation of the quantitative patterns. This design was guided by the theoretical frameworks outlined in the literature review (TAM, UTAUT, HMSAM, SDT, Flow Theory, and Cognitive Load Theory), enabling the study to examine both utilitarian dimensions (e.g., perceived usefulness, perceived ease of use) and hedonic dimensions (e.g., enjoyment, immersion) of ChatGPT use, alongside professional identity factors relevant to ELT majors. Combined, the two phases afforded an in-depth understanding of how ELT students interacted with ChatGPT as language learners and prospective teachers.

3.2 Research Questions

The research sought to answer the following research questions:
What motivates ELT students to use ChatGPT for writing, speaking, reading, and vocabulary learning?
How do intrinsic, extrinsic, hedonic, and technological motivations differ across language skills and relate to students' intention to use ChatGPT?
How do ELT students perceive the pedagogical, ethical, and professional implications of ChatGPT use?

4. Participants

The quantitative sample consisted of 100 English Language Teaching (ELT) undergraduates from nine universities in North Cyprus, selected among 450 ELT student-population through proportionate stratified random sampling to ensure representation across institutions and year levels. Participants ranged from 18 to 27 years old, with 53% female, 46% male, and 1% nonbinary. Their English

proficiency ranged from B1 to C1 (CEFR). Most participants had prior exposure to ChatGPT, though their frequency and purposes of use varied. The qualitative phase involved 12 students, selected through purposive sampling to represent diverse motivational profiles, skill-specific usage patterns, and ethical stances identified in the quantitative phase. This ensured that the qualitative data captured a wide range of perspectives rather than only those of highly motivated or highly critical users.

5. Instruments

5.1 Survey Instrument

A structured survey instrument was developed drawing on TAM, UTAUT, HMSAM, SDT, Flow Theory, and CLT to capture motivational and skill-specific dimensions of ChatGPT use. The instrument consisted of 42 items across nine constructs (intrinsic motivation, extrinsic motivation, hedonic motivation, perceived usefulness, perceived ease of use, social influence, ethical concerns, intention of use, and skill-specific ChatGPT use. Items were rated on a 5-point Likert scale (See Appendix A) The survey also included six demographic questions (age, gender, year of study, proficiency level, prior ChatGPT experience, and frequency of use.
Content validity was ensured through expert review and a pilot study. A pilot study conducted with 15 ELT students to evaluate item clarity, response patterns and completion time. Participants completed the full survey and provided written feedback. Minor wording changes were made (e.g. simplifying technical terms such as “focused immersion”), and two items were removed due to conceptual overlap. None of the participants reported any problems understanding the items. In addition to qualitative feedback, the pilot data were subjected to preliminary factorability checks. Exploratory Factor Analysis (EFA) was conducted using principal axis factoring with varimax rotation. The Kaiser-Meyer-Olkin (KMO) value exceeded the recommended .60 threshold and Bartlett’s Test of Sphericity was significant ($p < .001$) indicating that the correlation matrix was suitable for factor analysis. The nine-factor structure aligned with the theoretical constructs (IM, EM, HM, PU, PEOU, SI, ETH, INT, SSU), with all retained items loading above .40. Reliability analyses showed strong internal consistency across all subscales ($\alpha = .80–.91$). The instrument thus provided a robust measure of ELT students’ motivations, perceptions, and ethical awareness in AI-mediated learning. The full factor loading matrix is provided in Appendix C (Table 1) to ensure methodological transparency.

5.2 Semi-Structured Interview Protocol

Semi-structured interview protocol included 2 warms up and 16 guiding questions (see Appendix B). Semi-structured interviews were conducted to deepen the quantitative findings and gain a richer understanding of ELT students’ perceptions and experiences with ChatGPT. The interviews explored learners’ use of ChatGPT across language skills (writing, speaking, reading, vocabulary), perceived benefits and limitations, ethical concerns such as plagiarism, overreliance, and fairness, pedagogical beliefs about AI integration, and the influence of ChatGPT on their emerging professional identities. The interview protocol was informed by prior research on preservice teachers’ perceptions of AI and technology-enhanced learning (Guan et al., 2025; Üretmen K. & Doğan, 2025; Kuzu, 2025). The semi-structured format ensured consistency across participants while allowing for probing and follow-up questions to elicit deeper insights. Each interview lasted 20–30 minutes, was audio-recorded with informed consent, and transcribed verbatim for analysis.

6. Data Collection Procedures

Data were collected using a two-phase sequential explanatory mixed-methods design, whereby quantitative data were first collected and qualitative data used to elaborate upon and explain survey findings.
Phase 1: Quantitative data Collection
The target population consisted of approximately 450 ELT students, enrolled across nine universities. Proportionate stratified random sampling ensured representation from each institution: each university served as a stratum, and participants were randomly invited in numbers proportional to its ELT student population. The survey was administered online using Google Forms, and participation was voluntarily and anonymous. To minimize response emphasized ChatGPT use in language learning without highlighting motivational constructs. A total of 100 students completed the survey.
Phase 2: Qualitative data collection

Following the survey, a purposive subsample of participants (12 of 100 ELT students) was invited for semi-structured interviews to capture the variation in ChatGPT use frequency and skill-specific engagement. Interviews were conducted either face-to-face or via Zoom, depending on the participant's comfort level. Each session lasted about 20-30 minutes, was audio-recorded with informed consent, and transcribed verbatim. Thematic analysis was used to identify patterns related to learners' experiences, perceived benefits and challenges, ethical considerations, and emerging professional identities.

7. Data Analysis

7.1 Quantitative Analysis

Quantitative data were analysed using SPSS and AMOS following a sequence consistent with the explanatory design. Descriptive statistics summarized students' frequency of ChatGPT use across the four language skills. Reliability analyses showed high internal consistency for all motivational and technology-acceptance constructs (α = .86–.92), supporting the suitability of the measurement model. A structural equation model (SEM) was then tested to examine predictors of intention to use ChatGPT, including intrinsic, extrinsic, and hedonic motivation, perceived usefulness, perceived ease of use, and social influence. Finally, ANOVA was conducted to compare motivational differences across writing, speaking, reading, and vocabulary. Although motivation is often explored qualitatively, the present study operationalized skill-specific motivation quantitatively by including four parallel sets of items measuring motivation for writing, speaking, reading, and vocabulary. Because each skill had its own composite motivation score, ANOVA was appropriate for comparing mean differences across these four dependent variables. This sequenced analysis provided a solid foundation for interpreting ELT students' motivation and technology-acceptance patterns.

7.2 Qualitative Analysis

Qualitative data were analysed thematically using Braun and Clarke's (2006) six-phase framework. Coding proceeded through open coding (identifying initial meaning units), axial coding (grouping related codes), and selective coding (developing overarching themes). Themes reflected the study's focal areas: skill-specific experiences with ChatGPT, motivational factors, ethical concerns, pedagogical beliefs, and emerging professional identity. Participant descriptors (e.g., year of study, proficiency level) were used when relevant to contextualize perspectives. Triangulation with quantitative findings strengthened interpretive validity by explaining, extending, or contrasting patterns identified in Phase 1.

8. Results

8.1 Quantitative Results

Descriptive results showed clear skill-specific differences in ChatGPT use. Writing was the most frequently used skill (87% frequent/very frequent), followed by vocabulary (78%), reading (71%), and speaking (62%). Writing also elicited the strongest intrinsic and hedonic motivation, with students reporting enjoyment, reduced anxiety, and support for idea generation. Speaking motivation was shaped by affective benefits such as increased confidence and reduced communication apprehension, whereas reading and vocabulary use were driven more by extrinsic, efficiency-oriented motives.

Reliability analyses demonstrated strong internal consistency across all motivational and technology-acceptance constructs (α = .86–.92), including intrinsic motivation (α = .89), extrinsic motivation (α = .86), hedonic motivation (α = .91), perceived usefulness (α = .88), perceived ease of use (α = .90), and intention to use (α = .92). Confirmatory Factor Analysis indicated good model fit (CFI = .95, RMSEA = .05), supporting the validity of the measurement model. Table 2 gives a complete overview of reliability and validity indices.

Table 2. Reliability and Validity Results for Measurement Model

Construct	Cronbach's α	Composite Reliability (CR)	Average Variance Extracted (AVE)	CFI	RMSEA
Intrinsic Motivation	.89	.90	.65	.95	.05
Extrinsic Motivation	.86	.88	.61	.95	.05
Hedonic Motivation	.91	.92	.68	.95	.05
Perceived Usefulness	.88	.89	.63	.95	.05
Perceived Ease of Use	.90	.91	.66	.95	.05
Intention to Use	.92	.93	.70	.95	.05

Structural equation modelling further showed that intrinsic motivation (β = .41, p < .001), perceived usefulness (β = .33, p < .001), hedonic motivation (β = .29, p < .01), and perceived ease of use (β = .21, p < .05) significantly predicted intention to use ChatGPT, while social influence and extrinsic motivation were nonsignificant predictors (β = −.11 to .06). Intrinsic motivation emerged as the strongest predictor of intention (Table 3).

ANOVA results revealed significant differences in motivational patterns across the four language skills. Writing showed the highest intrinsic and hedonic motivation, while speaking was associated with affective motivation (reduced anxiety, increased confidence). Reading demonstrated the strongest extrinsic motivation, particularly related to efficiency and clarity, and vocabulary reflected a mixed intrinsic–extrinsic profile. Post hoc tests indicated that motivation for writing was significantly higher than for reading and vocabulary (p < .01), whereas differences between writing and speaking were not significant (Table 4).

Table 3. SEM Regression Weights Predicting Intention to Use ChatGPT

Predictor	β	p-value
Intrinsic Motivation	.41	< .001
Perceived Usefulness	.33	< .001
Hedonic Motivation	.29	< .01
Perceived Ease of Use	.21	< .05
Social Influence	—	n.s.
Extrinsic Motivation	—	n.s.

Note. Intrinsic motivation emerged as the strongest predictor of intention to use ChatGPT.

Table 4. Skill-Specific Motivational Patterns Based on ANOVA

Skill	Dominant Motivational Pattern	Post Hoc Comparison vs Writing
Writing	Intrinsic + Hedonic	—
Speaking	Affective (confidence, reduced anxiety)	n.s.
Reading	Extrinsic (efficiency)	Lower than Writing (p < .01)
Vocabulary	Mixed intrinsic–extrinsic	Lower than Writing (p < .01)

Note. Writing showed significantly higher motivation than reading and vocabulary

8.2 Qualitative Results

The qualitative stage added depth to the survey by examining how ELT students personify their interactions with ChatGPT and interpret its pedagogical, ethical, and professional implications. While quantitative findings revealed motivational patterns across skills, interviews clarified why students felt motivated, how they perceived benefits and risks, and what this meant for their emerging teacher identities. A thematic analysis of 12 interviews yielded five overarching themes.

Theme 1: Writing for Creativity and Confidence Students described ChatGPT as a remedy for writer's block, supporting idea generation, grammar, and vocabulary, while reducing anxiety.

"ChatGPT allows me to write without getting writer's block" (Female, 2nd year, B2).

These insights align with quantitative findings and prior studies (Teng & Huang, 2025; Xu & Jumaat, 2024; Lee et al., 2025).
Theme 2: Speaking for Confidence and Reduced Anxiety ChatGPT was seen as a non-judgmental conversation partner for rehearsing presentations and dialogues.
“I can practice speaking without feeling ashamed. It gives me courage” (Male, 1st year, B1).
This affective dimension resonates with Carrera Nuñez et al. (2025), who found reduced speaking anxiety and greater willingness to communicate.
Theme 3: Reading and Vocabulary for Efficiency Participants valued ChatGPT’s ability to simplify texts, summarize readings, and explain vocabulary quickly.
“It saves time. I understand texts faster” (Female, 1st year, B1).
These findings corroborate the efficiency-driven motivation identified in the survey and reflect CLT interpretations of reduced extraneous load.
Theme 4: Ethical Dilemmas Students expressed ambivalence, noting risks of plagiarism, overreliance, and fairness in assessment.
“My fear is that if I rely on it too much, I will become reliant” (Male, 4th year, B2).
Such concerns echo Tüm (2026), Üretmen K. and Doğan (2025), and Guan et al. (2025), underscoring the need for ethical guidelines and AI literacy.
Theme 5: Professional Identity As future teachers, participants reflected on AI’s role in pedagogy, assessment, and ethical modelling.
“We have to teach people how to relate to AI in the right way” (Non-binary, 4th year, C1).
These reflections are consistent with Kuzu (2025) and Guan et al. (2025), who highlight preservice teachers’ curiosity and concern about integrating AI.
The five themes illustrate how ELT students positioned ChatGPT as both a motivating resource and a pedagogical challenge. They reported reduced anxiety, greater confidence, and efficiency gains across writing, speaking, reading, and vocabulary, while also voicing concerns about ethics, integrity, and dependence. Reflections further revealed growing awareness of AI’s potential to reshape pedagogy, assessment, and professional roles. Overall, the findings portray ELT students as engaged yet cautious users who balance motivation and affective benefits with ethical considerations and their emerging teacher identity.

8.3 Mixed Methods Integration of Results

The qualitative themes confirmed and elaborated on the quantitative patterns: interviews showing reduced anxiety and greater creativity supported high intrinsic and hedonic motivation for writing, while survey data reinforced affective benefits in speaking. Reading and vocabulary emerged as efficiency-driven skills, and ethical concerns surfaced consistently across both phases, highlighting calls for AI literacy and responsible use. Taken together, these converging findings provide a coherent view of ELT students’ motivations and perceptions of ChatGPT, portraying them as engaged yet reflective users who balance personal drives and affective needs with ethical reasoning and their developing professional identity.

9. Discussion and Synthesis

This mixed methods study advances understanding of ELT students’ motivation to use ChatGPT and their perceptions of its pedagogical and ethical implications across writing, speaking, reading, and vocabulary. Writing emerged as the most motivating skill, with students viewing ChatGPT as a supportive “thinking partner” that reduced anxiety and enhanced fluency, consistent with Teng and Huang (2025), Xu and Jumaat (2024), and Ibrahim and Kirkpatrick (2024). Speaking motivation was largely affective, as students valued ChatGPT’s role in easing communication apprehension and building confidence, echoing Carrera Nuñez et al. (2025) and Celik et al (2025). Reading and vocabulary were efficiency-driven, aligning with TAM and CLT’s emphasis on perceived usefulness and reduced cognitive load.
Structural modelling confirmed that intrinsic motivation, perceived usefulness, hedonic appeal, and ease of use were the strongest predictors of intention to use ChatGPT, in line with Lai et al. (2023), Wang and Fan (2025), and Wang et al. (2025). Ethical ambivalence was evident, with concerns about plagiarism, dependence, and fairness (Tüm, 2026; Üretmen K. & Doğan, 2025; Guan et al., 2025), underscoring the need for AI literacy and clear guidelines. At the same time, students reflected on their dual identity as learners and future teachers, recognizing AI’s potential for differentiation, scaffolding, and assessment reform (Guan et al., 2025; Kuzu, 2025; Nunes et al., 2022).

Overall, the findings portray ELT students as engaged yet cautious users who balance motivation and affective benefits with ethical reasoning and professional reflection. ChatGPT's role is strongest in affective scaffolding for writing and speaking, while reading and vocabulary use remain efficiency-driven. These multiple dimensions suggest that AI integration in ELT programs must address not only skill-level learning but also broader concerns of integrity, responsible use, and teacher preparation.

10. Implications

This study highlights the need for individualized integration of AI into ELT programs, addressing not only skill-specific learning but also broader concerns of ethics, assessment integrity, and teacher preparation. Writing and speaking emerged as highly motivating, suggesting curricula should incorporate structured AI-supported tasks alongside explicit training in prompt design, critical evaluation, and ethical decision-making (Ibrahim & Kirkpatrick, 2024). Teacher education must prepare ELT majors for AI-mediated pedagogy, offering strategies for differentiation, feedback, and scaffolding, while modelling responsible use (Guan et al., 2025; Kuzu, 2025).

Assessment practices require rethinking to preserve authenticity, with process-based formats, oral defences, and reflective commentaries mitigating risks of plagiarism and overreliance (Tüm, 2026). Finally, future research should pursue longitudinal and intervention-based designs to examine sustained motivational change, professional identity development, and the effectiveness of AI-integrated instruction across diverse contexts (Nunes et al., 2022).

11. Limitations and Future Research

This study offers valuable insights into ELT majors in North Cyprus, yet its findings cannot be generalized to broader EFL contexts or non-teacher education programs. The reliance on self-reported survey data may reflect perceptions more than actual behaviour, and while the mixed methods design mitigated this, future work should incorporate behavioural analytics and classroom observations. The qualitative sample of 12 provided depth but limited transferability, suggesting the need for larger or multi-site studies. Moreover, the analysis captured a single time point, despite the rapid evolution of AI tools and student practices, highlighting the importance of longitudinal research. Finally, the study did not empirically test AI-integrated interventions; experimental designs are needed to evaluate impacts on language development, autonomy, and critical AI literacy. Collectively, these limitations point to the need for more extensive, longitudinal, and intervention-based research to guide responsible AI integration in ELT programs.

12. Conclusion

Based on the frameworks of TAM, UTAUT, HMSAM, SDT, Flow Theory and Cognitive Load Theory this mixed-method study investigated ELT students' use motivation for ChatGPT with writing, speaking, reading and vocabulary. The quantitative results showed that intrinsic motivation, perceived usefulness, hedonic motivation and ease of use were the strongest predictors of intention to use ChatGPT. Writing was the most intrinsically and hedonistically motivating skill, while speak motivation was similarly driven by affective factors such as lowered anxiety and increased confidence. Reading and vocabulary use were mostly extrinsically motivated via efficiency and working memory reduction.

These results were further complemented by qualitative findings indicating that students experienced ChatGPT as a cognitive and affective writing scaffold, as a confidence builder for speaking, and an efficiency-enhancing tool for reading and vocabulary. Some participants also highlighted issues surrounding plagiarism, over-reliance and the loss of real learning. Being both learners and future teachers, raised their sensitivities on pedagogical and ethical implications frequently surrounding academic dishonesty due to clouded integrity in assessment and responsible use of AI.

In summary, the findings indicate that this necessitates AI literacy and ethical guidelines as well as a reassessment of evaluation within ELT programs. With AI shaping its way into language education environments, it is integral that teacher education curricula support the training of educators who will integrate AI tools in a pedagogically sound, responsible, and critical manner. Theoretical overviews of the usage and motivation of ChatGPT are sorely lacking in applied EFL contexts, which this study addresses, as it provides an ELT-focused understanding of ChatGPT use and motivation that is also skill specific and theory driven, whilst stressing the importance to prepare future teachers for working in what will soon be AI-rich environments.

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APPENDIX A

SURVEY INSTRUMENT
Title: Motivational Factors Influencing ELT Students' Use of ChatGPT Across Language Skills
Instructions to Participants

Thank you for participating in this study. The purpose of this survey is to understand your experiences and motivations when using ChatGPT for language learning. Your responses are anonymous and will be used for research purposes only.

Please answer each question honestly. For Sections 2–4, use the following scale:

1 = Strongly disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly agree

SECTION 1 — Demographics and Background
(Multiple choice / short answer)
D1. Age: ___ D2. Gender: ☐ Female ☐ Male ☐ Other
D3. Year of study: ☐ 1st ☐ 2nd ☐ 3rd ☐ 4th
D4. Frequency of ChatGPT use:
☐ Never
☐ Rarely
☐ Sometimes
☐ Often
☐ Very often

D5. Have you received any AI-related training?
☐ Yes
☐ No

SECTION 2 — General ChatGPT Use Patterns
(5-point Likert scale)

GU1. I use ChatGPT for academic tasks.
GU2. I use ChatGPT for language learning.
GU3. I use ChatGPT regularly for writing, speaking, reading, or vocabulary tasks.

SECTION 3 — Motivational and Acceptance Constructs
(5-point Likert scale)
Intrinsic Motivation (IM)

IM1. Using ChatGPT is enjoyable.
IM2. I feel curious when interacting with ChatGPT.
IM3. I feel motivated to explore ChatGPT because it is interesting.

Extrinsic Motivation (EM)
EM1. ChatGPT helps me complete tasks faster.
EM2. ChatGPT improves my academic performance.
EM3. Using ChatGPT helps me achieve better results in my coursework.

Hedonic Motivation (HM)
HM1. I feel immersed when using ChatGPT.
HM2. Using ChatGPT is fun.
HM3. I lose track of time when using ChatGPT.

Perceived Usefulness (PU)
PU1. ChatGPT improves my language learning.
PU2. ChatGPT enhances my writing and speaking skills.
PU3. ChatGPT helps me learn more effectively than traditional methods.

Perceived Ease of Use (PEOU)
PEOU1. ChatGPT is easy to use.
PEOU2. Learning to use ChatGPT is simple.
PEOU3. It is easy for me to become skilled at using ChatGPT.

Social Influence (SI)
SI1. People who are important to me think I should use ChatGPT.
SI2. My instructors encourage the use of ChatGPT.
SI3. My classmates think using ChatGPT is beneficial.

Ethical Awareness (ETH)
ETH1. I worry about plagiarism when using ChatGPT.
ETH2. I believe ChatGPT should be used responsibly.
ETH3. I am aware of the ethical risks associated with using ChatGPT.

Intention to Use (INT)
INT1. I intend to continue using ChatGPT.
INT2. I plan to use ChatGPT in future courses.
INT3. I will use ChatGPT regularly in my future learning.

SECTION 4 — Skill-Specific Engagement
(5-point Likert scale)
SSU1. I use ChatGPT for writing tasks.
SSU2. I use ChatGPT for speaking practice.
SSU3. I use ChatGPT for reading comprehension.
SSU4. I use ChatGPT for vocabulary learning.

APPENDIX B — Interview Protocol

Warm-Up
1. Can you describe a recent situation where you used ChatGPT for your coursework?
2. Which language skill do you feel ChatGPT supports the most, and why?

Writing
3. How does ChatGPT support your writing process?
4. What challenges do you face when using it for writing?

Speaking
5. How does ChatGPT influence your speaking confidence?
6. How do you use it for presentation or conversation practice?

Reading & Vocabulary
7. How does ChatGPT help you understand academic texts or course materials?
8. How do you use it to learn or practice new vocabulary?

Overall Benefits & Limitations
9. Overall, what do you see as the main **benefits** of using ChatGPT for your language learning?
10. What do you see as the main **limitations or drawbacks** of using ChatGPT across different skills?

Motivation & Perception
11. What motivates you to use ChatGPT for your learning?
12. Do you enjoy using it? Why or why not?

Ethics & Responsible use
13. What ethical concerns do you have when using ChatGPT (e.g plagiarism, over-reliance, fairness)?
14. How do you decide what is an appropriate or inappropriate way to use ChatGPT for coursework?

Pedagogical Beliefs
15. How do you think ChatGPT should be used in future ELT classrooms?
16. What role do you think AI tools should play in supporting language learning?

Professional Identity
17. How does using ChatGPT influence your identity as a future English language teacher?
18. Has ChatGPT changed the way you see your future teaching practices? If so, how?

APPENDIX C- Table 1. Exploratory Factor Analysis Findings (Principal Axis Factoring, Varimax Rotation)

Item Code	Factor 1 IM	Factor 2 EM	Factor 3 HM	Factor 4 PU	Factor 5 PEOU	Factor 6 SI	Factor 7 ETH	Factor 8 INT	Factor 9 SSU
IM1	.78	—	—	—	—	—	—	—	—
IM2	.74	—	—	—	—	—	—	—	—
IM3	.69	—	—	—	—	—	—	—	—
EM1	—	.72	—	—	—	—	—	—	—
EM2	—	.68	—	—	—	—	—	—	—
EM3	—	.64	—	—	—	—	—	—	—
HM1	—	—	.81	—	—	—	—	—	—

Item Code	Factor 1 IM	Factor 2 EM	Factor 3 HM	Factor 4 PU	Factor 5 PEOU	Factor 6 SI	Factor 7 ETH	Factor 8 INT	Factor 9 SSU
HM2	—	—	.77	—	—	—	—	—	—
HM3	—	—	.70	—	—	—	—	—	—
PU1	—	—	—	.83	—	—	—	—	—
PU2	—	—	—	.79	—	—	—	—	—
PU3	—	—	—	.75	—	—	—	—	—
PEOU1	—	—	—	—	.82	—	—	—	—
PEOU2	—	—	—	—	.78	—	—	—	—
PEOU3	—	—	—	—	.73	—	—	—	—
SI1	—	—	—	—	—	.76	—	—	—
SI2	—	—	—	—	—	.72	—	—	—
SI3	—	—	—	—	—	.69	—	—	—
ETH1	—	—	—	—	—	—	.77	—	—
ETH2	—	—	—	—	—	—	.73	—	—
ETH3	—	—	—	—	—	—	.70	—	—
INT1	—	—	—	—	—	—	—	.85	—
INT2	—	—	—	—	—	—	—	.82	—
INT3	—	—	—	—	—	—	—	.79	—
SSU1	—	—	—	—	—	—	—	—	.81
SSU2	—	—	—	—	—	—	—	—	.78
SSU3	—	—	—	—	—	—	—	—	.74
SSU4	—	—	—	—	—	—	—	—	.71

KMO = .89

Bartlett's Test of Sphericity = $\chi^2(435) = 2548{,}21$, $p < .001$

Total Variance Explained = 73.2%

Life Sciences Education

Co-Creating Environmental Solutions through Community-Based Science Education: A Participatory Situation Analysis, Philippines

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Abstract

The rapid pace of urbanization in Metro Manila poses more environmental issues within densely populated areas, like Tondo, Manila, which suffer from the improper waste disposal, environmental pollution, and insufficient availability of green spaces. The solution of these environmental issues is not only dependent on environmental intervention but on educating people about their surroundings. This paper investigates the use of Participatory Situation Analysis (PSA), within the context of Participatory Action Research (PAR), as an educational tool used for investigating local environmental issues and promoting active community participation. This research included the participation of members of the community, barangay officials, informal waste pickers, and environmental volunteers in selected areas of Tondo, Manila. Data were collected using various means, including interviews, household surveys, observations, analysis of documentation, mapping of the community, and community participatory workshops. Results show persistent environmental issues involving waste management, pollution, and lack of green spaces. However, more significantly, participatory learning processes facilitated community member ability to analyze environmental issues and understand the interrelationship between human actions and environmental condition. Community mapping and dialogue sessions helped improve environmental awareness, fostered collaboration, and emphasized the idea of collective environmental responsibility. This study shows that the Participatory Situation Analysis not only serves as a methodological instrument but also is applicable as an environmental education strategy, promoting community empowerment and environmentally sustainable practices. These results are significant for further development of community-based environmental education since the use of participatory methods helps enhance environmental literacy and promote sustainable practices in local communities.

Keywords: *participatory situation analysis, environmental governance, waste management, community participation, sustainability*

1. Introduction

Environmental problems associated with fast-growing cities have become not just environmental or governance issues but rather educational challenges. Environmental education helps people understand environmental problems, develop an attitude towards them, and participate in environmental decision making. When it comes to urban informal communities where people face various environmental challenges, it is possible to enhance their environmental literacy through educational methods based on practical application of theoretical knowledge.

Tondo, Manila, is considered one of the densest urban areas in the Philippines, suffering from multiple environmental problems like improper waste management, water pollution, pollution, and lack of green areas. This problem negatively impacts environmental conditions and affects people's health as well as sustainability. Despite the existence of governmental programs and environmental policies, sustainable development is dependent on active involvement of local communities and their environmental awareness

Learning from the environment using the community approach enables the locals to learn through observing, communicating, reflecting, and acting together in relation to the issues. Community-based environmental learning is premised on the theory of learning based on experiences and participatory education which acknowledges the community members as important participants in learning about the environment. Participatory Action Research (PAR) and Participatory Situation Analysis (PSA) are critical to the achievement of the objective in view because they provide opportunities for integrating local experiences and science to address the issues at hand.

Though there are numerous studies focusing on the relationship between environmental management and participation of the community members, few studies have focused on the significance of Participatory Situation Analysis (PSA) to environmental education within urban areas in the Philippines. This study, therefore, aims to fill the identified gap through an analysis of how PSA can contribute to environmental education within Tondo in Manila.

2. Objectives of the Study

2.1 General Objective

To examine how Participatory Situation Analysis can be utilized as a community-based environmental education approach to enhance environmental awareness, environmental literacy, and community participation in addressing environmental issues in Tondo, Manila.

Specific Objectives

1. To identify community knowledge and practices related to waste management and environmental conservation.
2. To examine residents' understanding of environmental pollution and its effects on human health and the environment.
3. To assess community awareness regarding the importance of green spaces and urban environmental sustainability.
4. To determine how participatory learning activities influence environmental awareness and community engagement.
5. To develop community-based environmental education strategies that support sustainable environmental practices and local environmental governance.

3. Methodology

3.1 Research Design

For the current study, the methodology used was Participatory Action Research (PAR). Participatory Situation Analysis was the main methodological framework used for this purpose. The essence of PAR is that it is a research process that involves collaborative inquiry, where community members take part in problem identification and formulation of solutions.

3.2 Study Area and Participants

The study was done in selected areas of Tondo, Manila, an urbanized municipality distinguished by its congested populace, minimal infrastructure, and environmental problems. Subjects of the study comprised community members, barangay officials, waste pickers, and environmental volunteers. The use of purposive sampling was done to ensure that the respondents belonged to varied community perspectives, especially those who are directly linked with environmental activities.

3.3 Data Collection Methods

Triangulation of data involved several approaches including:

• Semi-structured interviews with community members
• Surveys of households on waste management issues
• Field observations at waste dump sites and community settings
• Barangay records and reports on environmental programs
• Workshops using community maps and environmental visi

3.4 Data Analysis

Analysis of qualitative data involved the use of thematic analysis, which focused on identifying common themes relating to the environment and patterns of community reactions. Descriptive statistics were used to analyze quantitative data collected through surveys.

4. Significance of the Study

The present study is a valuable addition to the body of research in environmental education because it shows the importance of using participatory methods for fostering environmental awareness and community involvement in urban areas. At the individual level, it enables community members to engage in reflection regarding the environmental problems that impact them directly and to get involved in solving them. At the organizational and policy-making levels, on the other hand, the results provide important information to local government units and barangay leaders about the value of supplementing existing environmental programs with efforts aimed at fostering environmental awareness and community participation through environmental education. This study also holds relevance to academic discussions in community-based environmental education and environmental literacy.

5. Conceptual Framework

The research is additionally based on the concepts related to community-based science education, which involve experiential learning, participatory investigation, and environmental understanding within particular settings. In such a case, education involves discussion, observation, reflection, and solving problems in relation to the particular community. Workshops held within PSA involved data collection but were also educational as individuals were encouraged to discuss their environments, share experiences, and establish environmental awareness. Such an approach is aligned with that proposed by Freire and referred to as dialogic education, involving learning through collective reflection and action (Freire, 1970).



6. Results and Discussion

These results indicate that participation in environmental learning activities is crucial for enhancing the practice of waste management. In particular, the community discussions and PSA sessions allowed the residents to think critically about the issue of waste disposal, its negative impact on environmental health, and their role in addressing this problem within the community. Thus, the study shows how community-based science education helps enhance individuals' awareness of environmental issues.
Besides helping to identify environmental conditions, these participatory approaches were effective in promoting environmental learning. Residents were able to consider the causes and effects of environmental problems based on their personal observations and experiences. By reflecting upon these processes, participants gained an enhanced understanding of how human actions affect environmental quality. This type of environmental learning aligns with the basic concepts of environmental education.

6.1 Waste Management Practices

Table 1. Waste Management in the Community

Waste Management Patterns	1	2	3	4	Other Answers
WM1: Waste generation (types, quantities)	There are assigned street sweepers and garbage trucks collecting garbage everyday (4)	Waste segregation is being practiced (3)	There is a lot of garbage due to overpopulation (2)	WM1: Waste generation (types, quantities)	There are assigned street sweepers and garbage trucks collecting garbage everyday (4)
WM2: Waste collection and disposal methods (segregation, recycling, landfill)	They are observing waste management such as collecting the garbage every morning and afternoon (10)	There are declogging, clean up drive and recycling activities initiated by the barangay (5)	—	—	They are observing waste management such as collecting the garbage every morning and afternoon (10); There are declogging, clean up drive and recycling activities initiated by the barangay (5)
WM3: Informal waste management practices (scavenging, dumping)	There are scavengers looking for recyclable waste (4)	Dumping garbage at the back of the building (1)	—	—	—
WM4: Waste treatment facilities and their effectiveness	There are assigned street sweepers and garbage trucks collecting garbage everyday (6)	There are declogging, clean up drive and recycling activities initiated by the barangay (3)	There is a detection device for copper, bronze, and brass burning (Pagsusunod ng tanso) (2)	—	—
WM5: Environmental impacts of waste management (pollution, health risks)	Too hot weather sometimes causes fire on the mountain. It also has extracted that stink (4)	Clean surroundings provide good health (3)	The quality of soil is contaminated. Plants are difficult to grow (1)	—	—
WM6: Public awareness and participation in waste management	There are clean up drives and assigned street sweepers. There are also garbage trucks collecting garbage everyday (6)	There is a MRF project by the barangay (2)	There are designated trash cans every building (1)	—	—

From the study, it is evident that there is a dual waste management system that includes the use of both official municipal waste disposal and unofficial recovery practices. There was evidence of regular garbage collection and street sweepers in some sections of the barangay. On the other hand, there was evidence of the practice of waste scavenging for the purpose of resource recovery and recycling of recyclable materials in most waste dump sites. Waste scavengers form an important aspect of any recycling systems in developing countries. They contribute a lot to resource recovery and the circular economy process (Medina, 2007; Wilson et al., 2006). - The waste collection takes place by truck whereas bulldozers gather the rest of the waste materials. A total of 12 community volunteers handle the waste material from the MRF. The volunteers do not use personal protective equipment (PPEs), putting their lives in danger, along with that of the collectors and scavengers. Such cases have been observed in many parts of Metro Manila where the work of waste scavengers was crucial to resource recovery and recycling processes (Gutberlet et al., 2021).

While formal waste collection services are provided, illegal dumping practices were also noted during the study. Some participants stated that trash was disposed of at the back of buildings or in open areas from time to time, posing problems with foul smells, pests, and even fires during dry weather.

These results are consistent with earlier studies that have found that informal settlements in urban settings function under a mixed economy of waste systems, whereby formal waste management processes exist alongside informal recycling methods (Serrona & Yu, 2009). Although the practice of informal waste picking creates jobs, it is important for policymakers to pay attention to the issue of informal waste management governance as well. As far as involvement in environmental efforts by local communities is concerned, barangay clean-ups and street sweepings were noted as forms of engagement by community members in environmental issues. Yet, some participants were unaware about the barangay MRF, suggesting a lack of integration between current waste management policies and practices in the community.

The difficulties related to illegal dumping and waste management become more pronounced in the case of Tondo. The community encounters serious environmental threats associated with improper waste disposal practices. The lack of law enforcement results in an increase in the number of illegal dumping locations, thus posing various environmental threats. Besides, insufficient public knowledge about the issue in question adds up to existing difficulties related to waste management. It can be stated that governance problems could be successfully dealt with in Tondo.

6.2 Pollution Sources and Environmental Impacts

These activities have also offered chances for environmental learning by the citizens. The discussions enabled them to relate their environmental surroundings such as polluted rivers, toxic soil, and emission of smoke with more extensive environmental impacts on the public. This indicates how community science plays a part in turning environmental surroundings into environmental learning.

Table 2. Pollution Patterns in the Community

Pollution Patterns	1	2	3	4	Other Answers
POL1: Air pollution (sources, types, effects)	Burning of wires for copper, bronze, or brass is already prohibited (7)	Too hot weather sometimes causes fire on the mountain. It also stinks (2)	—	—	—
POL2: Water pollution (sources, types, effects)	The water from the faucet is cleaner than the water coming from the water tank. The water coming from the water tank is not potable (8)	There is a good water supply (3)	Some are buying mineral water (2)	Sometimes, when it is high tide, the water from the river stinks (1)	The plastic bottles floating on the river (1)

Pollution Patterns	1	2	3	4	Other Answers
POL3: Soil pollution (sources, types, effects)	Due to over population and crowded building, there is no place for planting (3)	Heavy rains cause landslide and soften the soil (2)	The quality of soil is contaminated. Plants are difficult to grow (1)	—	—
POL4: Noise pollution (sources, effects)	Because of over population, there is a noise pollution especially during weekends or if there is occasion (5)	The place is quiet (2)	The vehicles passing through also contribute to noise pollution (1)	—	—
POL5: Regulations and enforcement related to pollution control	Waste segregation, detection mechanism for copper, bronze, and brass burning, and dumping site (5)	Street sweepers assigned by the barangay (2)	—	—	—

The residents reported several types of pollution in their area, ranging from air, water, soil, and noise pollution. The main sources of air pollution involved the burning of metal wires and other waste products. It should be emphasized that such activities are banned, although residents report instances when burning of such materials occurs; consequently, toxic substances in the form of fumes are released into the atmosphere. This problem can be regarded as an example of difficulties that arise in the enforcement of environmental policies in informal urban settlements. Water pollution was another critical issue. According to respondents, although tap water can be regarded as clean, water in storage tanks was believed to be unsuitable for consumption purposes. Besides, during high tide, river water smelled bad and contained various plastic wastes. Such facts can be compared with results of earlier studies reporting issues associated with water quality in informal settlements adjacent to water bodies in Metro Manila (Casiw, 2020). Moreover, inadequate waste management led to the pollution of soil, making it impossible to plant any vegetation.

The study also found that heavy rainfall led to poor soil stability and soil contamination. In addition, noise pollution proved to be another environmental problem brought about by high population densities and higher incidences of human activities. Noise pollution was found to be higher when there were meetings or traffic congestion. From the results obtained, it can be seen that environmental problems in Tondo are inter-related.

6.3 Green Spaces and Urban Environmental Quality

Further small-scale planting programs showed how participatory environmental actions could be educational. The people were not only involved in the planting process itself but also in conversations about the heat in urban areas, ecology, and wellbeing within the community. These examples show that environmental education can result from community actions, rather than being confined to classroom education only.

Table 3. Green Spaces in the Community

Green Spaces Patterns	1	2	3	4	Other Answers
GS1: Types of green spaces (parks, gardens, forests)	There is an ongoing barangay project for planting (3)	Upper part of the mountain used for planting vegetables, Barangay project for vegetation (1)	—	—	—

Green Spaces Patterns	1	2	3	4	Other Answers
GS2: Accessibility and availability of green spaces	No area because the area is crowded with buildings (1)	Very few because the soil is contaminated. (1)	—	—	—
GS3: Quality and maintenance of green spaces	The barangay is clean every morning and afternoon because of the street sweepers (1)	—	—	—	—
GS4: Ecological functions of green spaces (biodiversity, climate regulation)	Solar system and generator charge problem (1)	—	—	—	—
GS5: Public use and enjoyment of green spaces	It is in order (1)	—	—	—	—
GS6: Urban planning and green infrastructure development	Barangay project for development of the community such as planting and recycling (3)	There is a mountain where they plant (2)	—	—	—

In general, it can be seen that there is a significant absence of green spaces in the community. Some of the respondents have identified that there are some planting efforts initiated by the barangay, specifically in the mountain areas. These places are used sometimes for gardening. However, there are also many areas that do not have any green space at all due to high population density and the presence of residences that occupy the area. In addition, there does not seem to be any effort in the maintenance of green spaces in the community other than those done by street cleaners. This suggests that the ecological benefits are less present in the barangay. The scarcity of green spaces in urban informal communities has been extensively studied in urban planning literature. The importance of green infrastructure in urban areas is crucial for enhancing environmental quality, cooling urban areas, and ensuring the well-being of residents (Newman & Jennings, 2008; UN-Habitat, 2020).
Nevertheless, there were indications that the community was showing interest in greening activities. The barangay's tree planting program and the planting of vegetable gardens are clear indicators that the community is willing to participate in efforts to improve the environment. These observations indicate that green community-based interventions like container gardening, roof-top planting, and vertical gardening could be viable solutions for urban environmental improvement in space-strapped communities

7. Conclusion

This study illustrates how Participatory Situation Analysis is not just a way of analyzing the environmental status of the community but also an effective environmental education tool. By means of community mapping, discussions, observations, and reflections, the residents were able to enhance their knowledge about the environmental problems and develop their sense of responsibility for environmental protection. Some of the results obtained from the study indicate the existence of persistent problems regarding waste disposal, pollution, and lack of green areas in Tondo, Manila. On the other hand, the participants of the process acquired environmental literacy and knowledge through collective learning and community engagement. Environmental education should be integrated in community-based environmental programs in order to promote responsible community involvement in environmental activities.

It can be observed that environmental governance in informal urban settlements is closely intertwined with community learning and environmental education. In this regard, Participatory Situation Analysis can be considered not just a methodological approach for conducting research but also an instrument for community-based science education, whereby residents analyzed the local environment, shared their experiential knowledge, and thought collectively about what they could do environmentally. Thus, the research indicates that participatory approaches contribute to fostering environmental awareness and promoting environmental stewardship on a local level.

In this study, Participatory Situation Analysis has been demonstrated to be not just a research methodology but also a tool for community-based science education among urban poor communities in the Philippines. Through participatory workshops and other educational methods, residents were able to engage in learning about the environment based on scientific insights.

Environmental problems related to waste management, pollution, and lack of green growth infrastructure have been identified in Tondo, Manila. The research indicates that participatory education can help foster environmental awareness and promote participation in environmental governance processes.

Though there are other studies done on participatory environmental education around the world, what is provided here is unique data gathered within the Philippine urban setting. Thus, this research adds to existing studies on community-based environmental education in its illustration of how participation in learning can contribute to environmental initiatives in underdeveloped urban communities.

For the government, it is recommended that the promotion of environmental literacy, inclusion of informal waste workers in community-based education, and implementation of participatory green infrastructure be considered for policy development.

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Mathematical Sciences

Not Anxious or Confident: A Framework of Why Mathematics Apathy is a Barrier for Learning

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Abstract

Mathematics anxiety has been widely studied as a barrier to learning and achievement [1], yet mathematics apathy, characterised by low perceived value and low perceived control, remains underexplored despite its significant impact on student engagement and achievement [2]. This paper introduces a theoretical framework situating mathematics apathy within the Control-Value Theory of Achievement Emotions [3] underpinned by principles of Social Cognitive Theory [4]. Drawing on longitudinal survey data from over 1,200 UK secondary students, this study traces how mathematics apathy develops over time.

This paper argues that mathematics apathy warrants recognition as a distinct emotional barrier with unique implications for learning. Unlike mathematics anxiety, which is activating and often distressing, mathematics apathy is deactivating: it reduces effort, persistence, and willingness to engage with challenge. This paper invites dialogue on how teacher preparation and mentality can address mathematics apathy in their students, as a systemic barrier to mathematics education.

Keywords: *Mathematics apathy; Mathematics anxiety; Avoidance behaviours; Control value theory; Teacher resilience; Professional learning; Student Mentality*

1. Introduction

For decades, mathematics anxiety has dominated discourse on emotional barriers to mathematics learning. Its effects on avoidance, performance, and long-term participation are well documented [2][5][6][7]. Yet an equally pervasive phenomenon, mathematics apathy, has received far less attention. Mathematics apathy is not simply a lack of interest; it is similarly an achievement emotion shaped by students' perceptions of control and value [3]. When students believe they have little influence over their success and see limited relevance in the subject, apathy emerges as a protective disengagement strategy.

This paper argues that mathematics apathy warrants recognition as a distinct emotional barrier with unique implications for learning. Unlike anxiety, which is activating and often distressing, apathy is deactivating: it reduces effort, persistence, and willingness to engage with challenge. In classrooms, apathetic students may appear compliant yet disconnected, completing tasks without cognitive investment. Such disengagement is particularly concerning in mathematics, where conceptual understanding requires sustained attention and iterative reasoning.

Across the mathematics education literature, mathematics anxiety and mathematics confidence are frequently presented as opposing ends of a single affective continuum [8][9][10]. These early works demonstrated strong inverse relationships between confidence and anxiety in mathematics, a pattern later reinforced by a meta-analysis showing that higher mathematics confidence is consistently associated with lower mathematics anxiety [7]. Subsequent studies [6][11] have continued to treat the two constructs as conceptual dipoles linking low self-efficacy to heightened anxiety in mathematics contexts. While this one-dimensional framing has been valuable for understanding the interplay between confidence and anxiety, it does not fully account for the broader emotional landscape of mathematics learning. When examined through the lens of control value theory, the relationship between confidence and anxiety becomes part of a wider two-dimensional space in which perceived control and perceived value interact. This shift from a single continuum to a two-axis framework reveals additional emotional profiles beyond the traditional mathematics confidence mathematics anxiety dipole, including the low control, low value state that forms the basis of the construct I propose in this study: mathematics apathy.

2. Theoretical Framework

Pekrun's [3] control value theory (CVT) provides a powerful lens for understanding mathematics apathy. CVT proposes that achievement emotions stem from two appraisals: perceived control over learning and perceived value of the task or domain. Different combinations of these appraisals give rise to distinct emotional patterns. High control and high value appraisals generate positive activating emotions such as enjoyment or pride. Low control and high value appraisals often produce anxiety and nervousness. Low value and low control, however, generate deactivating emotions such as boredom, hopelessness, or apathy.

Within this framework, control and value are understood to develop together over time. Students' academic emotions emerge from the interaction of their control beliefs and value beliefs, meaning that the emotions they experience during a learning activity depend on how capable they feel and how much the task matters to them. CVT therefore provides a coherent structure for examining the emotional landscape of mathematics learning.

Through the control-value framework, mathematics anxiety is hypothesised to develop when a student experiences low control in a mathematics activity when they also experiencing a higher value appraisal towards mathematics [12]. Students who place strong importance on mathematics but feel unable to succeed are consistently found to report the highest levels of anxiety [12][13]. Low control in this context is closely associated with lowest levels of self-belief combining lower levels of perceived competence in tackling specific academic tasks (self-efficacy) and their general belief in being a 'good mathematician' (self-confidence). Using this framework of control-value theory and its application to mathematics anxiety a profile (see Figure 1) can be built showing the location of mathematics anxiety and three interconnected mathematics achievement emotions.

3. Defining Mathematics Anxiety

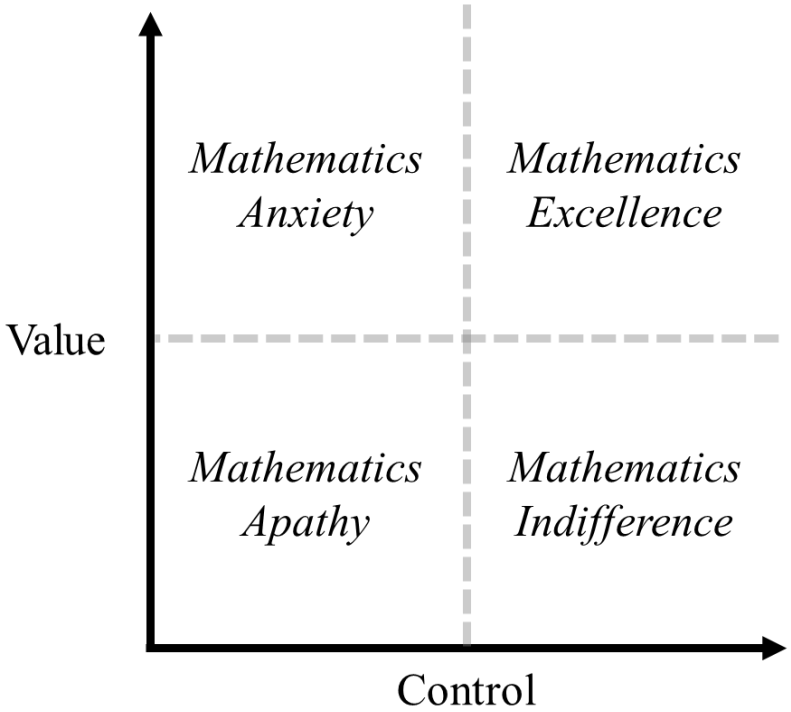


Fig. 1. Control-Value Theory Profile of Mathematics Achievement Emotions

Note. An original conceptual framework illustrating four distinct emotional responses to mathematics derived on Pekrun's [3] control-value theory: mathematics excellence (high value, high control), mathematics anxiety (high value, low control), mathematics indifference (low value, high control), and mathematics apathy (low value, low control).

Most notable is the lower left corner of the matrix corresponding to students with low levels of control and value. These students generally feel less competent (having little control over mathematics) nor invested in mathematics (attributing little value to mathematics), leading to disengagement and

emotional detachment. Control-value theory [3] predicts that when both perceived control and task value are low, students experience deactivating negative emotions. Therefore, and building on this framework, for students with low control and task value I propose the term mathematics apathy, defined originally here as:

> "A motivational deficit in which learners neither value nor expect success in mathematics – often connected to mathematics anxiety, mathematics apathy is underpinned by a lack of self-confidence and self-efficacy."

Zones of proximal development [14] offers a useful lens for understanding the emergence of mathematics apathy. When classroom tasks fall substantially below a learner's developmental level, they fail to generate cognitive challenge, resulting in limited motivation to participate or improve. Conversely, when tasks sit persistently beyond a student's perceived capability, they reinforce feelings of inadequacy and disengagement. In both cases, the misalignment between task demand and learner readiness contributes to a deactivation of effort.

Social cognitive theory [4][15] further illuminates this dynamic. Low self-efficacy diminishes students' willingness to attempt mathematical tasks, while the absence of perceived value erodes any incentive to persist when difficulties arise. Apathy, therefore, can be understood as the product of a dual erosion: students feel neither capable of success nor convinced that success matters. This combination aligns closely with the low control, low value quadrant of [3] control value theory, positioning apathy as a theoretically distinct emotional state rather than a simple lack of motivation.

As curricular complexity increases, repeated experiences of low control, such as difficulty with foundational concepts, and low value, such as limited real-world applications compound over time, reinforcing patterns of disengagement. These experiences shape the student's mathematics mentality: their combined beliefs, emotions, and expectations that frames their relationship with the mathematics.

Crucially, mathematics apathy does not always manifest as overt resistance. Many apathetic students maintain behavioural compliance while disengaging cognitively, completing tasks with minimal investment. This quiet disengagement makes apathy difficult for teachers to detect and easy for systems to overlook. Its subtlety underscores the need for teacher education programmes to address apathy explicitly as a distinct emotional barrier, equipping teachers to recognise its signs and respond with pedagogical strategies that rebuild both perceived control and perceived value.

4. Empirical Evidence

Although the present paper is theoretical in focus, illustrative evidence from a longitudinal study [18] of UK secondary students provides empirical plausibility for the proposed construct of mathematics apathy. The dataset, drawn from three secondary schools and comprising matched responses from 1,246 students aged 11–14, offers insight into how students' emotional profiles in mathematics evolve over time and how these trajectories align with the low control, low value quadrant predicted by Control Value Theory.

Two waves of data collection were conducted during the school year, with 1,545 students participating in Phase A and 1,560 in Phase B, yielding the 1,246 matched cases used for longitudinal analysis. Students completed validated measures of mathematics anxiety and mathematics confidence. Mathematics anxiety was assessed using the Modified Abbreviated Math Anxiety Scale, a nine-item instrument in which students rated their anxiety in response to common mathematics situations on a five-point scale ranging from "1 = Low Anxiety" to "5 = High Anxiety." Mathematics confidence was measured using an adapted version of the Mathematics Confidence Scale, comprising seven items rated on a symmetrical five-point agreement scale. Minor linguistic adjustments (e.g., "math" to "maths") ensured cultural relevance for UK students.

As reported in earlier analyses [18], "students' mathematics anxiety (at both the overall and component levels) decreases throughout secondary education, however there is no corresponding increase in mathematics confidence." This finding is striking because it challenges the long-standing assumption that reductions in anxiety naturally and consequently lead to increases in confidence.

Instead, the data suggest a more complex emotional shift. Students become less anxious about mathematics over time, but they do not become more confident. The emotional energy previously tied to worry, tension, and fear does not appear to be redirected into positive self-belief or engagement.

This pattern is precisely what the proposed construct of mathematics apathy predicts. When perceived control remains low—students still doubt their ability to succeed—but perceived value also declines,

reductions in anxiety do not produce positive affective states. Instead, students may shift into a deactivating emotional state characterised by detachment, low investment, and minimal cognitive engagement. The longitudinal data therefore provide a direct empirical illustration of the theoretical model: a movement from the high value/low control quadrant (mathematics anxiety) toward the low value/low control quadrant (mathematics apathy).
Importantly, this shift is not easily observable in classroom behaviour. Many students who report declining anxiety but stagnant confidence continue to complete tasks and comply with classroom routines. Yet their cognitive engagement diminishes. This quiet disengagement aligns with the theoretical definition of apathy as a deactivating achievement emotion and underscores the need for teachers and researchers to attend to emotional states that are not outwardly disruptive.
Taken together, the longitudinal patterns provide illustrative support for the conceptual framework advanced in this paper. They demonstrate that emotional trajectories in mathematics are not linear and that reductions in negative activating emotions do not guarantee increases in positive activating ones. Instead, when both perceived control and perceived value remain low, students may drift into a state of mathematics apathy—an emotional profile that has been largely overlooked in the literature but may be central to understanding persistent disengagement in mathematics classrooms.

5. Discussion

The framework proposed in this paper positions mathematics apathy as a critical, yet under recognised, barrier to learning. By situating apathy within control value theory, it becomes possible to differentiate it from related constructs such as anxiety, boredom, or low motivation. The longitudinal patterns observed in the Lincolnshire dataset highlight the developmental nature of apathy and its entanglement with students' mathematics mentality.
When anxiety is reduced but confidence does not increase, the emotional energy previously tied to fear and worry is not redirected into positive engagement. The present findings raise an intriguing and underexplored question regarding the affective dynamics of mathematics learning. Students report reduced worry and nervousness about mathematics within and between school years without the theorised corresponding increase in confidence. Instead, the emotional energy previously directed towards managing mathematics anxiety is not converted into positive self-belief, self-efficacy, or engagement, instead it dissipates resulting in a general apathy towards mathematics.
For teacher education, the implications are clear: apathy must be addressed explicitly and systematically. Cultivating teacher resilience and embedding apathy awareness into professional learning are two promising pathways for change. These approaches recognise that emotional barriers to learning are relational and contextual, requiring teachers who are both emotionally equipped and pedagogically empowered. Future research should explore intervention models that target both control and value appraisals, as well as the role of school culture in shaping students' emotional experiences of mathematics. As mathematics education continues to grapple with issues of participation, equity, and identity, understanding and addressing apathy is essential.
Mathematics apathy represents a silent but significant barrier to learning. Unlike anxiety, which signals distress, apathy signals disconnection. By integrating apathy into theoretical, empirical, and teacher education discourse, this paper argues for a more comprehensive understanding of the emotional landscape of mathematics learning. Addressing apathy is not merely a pedagogical challenge—it is a systemic imperative that requires resilient teachers, informed professional learning, and a commitment to fostering meaningful mathematical experiences for all students.

6. Implications

The proposed construct of mathematics apathy carries significant implications for theories of achievement emotions. By formalising the low control, low value quadrant within Control Value Theory, the construct expands the emotional landscape available to mathematics education researchers and challenges the long-standing assumption that confidence and anxiety form a single affective continuum. Recognising apathy as a deactivating emotion foregrounds the importance of emotional states that do not manifest as distress but as quiet disengagement. In doing so, the construct offers explanatory power for patterns of student behaviour and affect that existing constructs (e.g., mathematics anxiety) cannot adequately capture.
The construct also opens new avenues for empirical research. Future work will need to develop and validate measures capable of distinguishing mathematics apathy from related constructs, as well as model the developmental trajectories of perceived control and value that give rise to it. Research should

examine how apathy interacts with students' mathematical identities, participation patterns, and long-term engagement with the subject. Interventions that simultaneously target control and value appraisals represent a promising direction, as does research exploring how school culture and classroom climate shape students' emotional experiences. Longitudinal and mixed methods designs will be particularly valuable for tracing how apathy emerges, stabilises, or shifts over time.

Finally, the construct has important implications for teacher education. Mathematics apathy must be addressed explicitly and systematically, requiring teachers who are both emotionally equipped and pedagogically empowered. Preparing teachers to recognise and respond to apathy involves embedding apathy awareness into teacher preparation programmes, developing pedagogical approaches that rebuild perceived control through scaffolding and mastery experiences, and enhancing perceived value through relevance, authenticity, and identity affirming practices. Supporting teacher resilience (Gu & Day, 2013) is essential for sustaining emotionally responsive teaching in the face of quiet disengagement. Addressing mathematics apathy is therefore not merely a pedagogical challenge but the potential solution for mathematical engagement.

7. Conclusion

Mathematics apathy represents a silent but significant barrier to learning. Unlike anxiety, which signals distress, apathy signals disconnection. By situating apathy within Control Value Theory and integrating insights from Social Cognitive Theory and ZPD, this paper offers a theoretical framework for understanding apathy as a distinct achievement emotion. Illustrative evidence suggests that reductions in anxiety without increases in confidence may lead to emotional disengagement rather than positive affect. Recognising and addressing mathematics apathy is essential for fostering meaningful mathematical experiences and supporting students' long-term participation in mathematics.

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AI Driven Prediction of Student Success in Engineering Mathematics: Integrating Course Performance, Academic Progression, and Mathematical Misconceptions

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Abstract

Early identification of students at risk of academic difficulties is a major challenge in engineering education. Mathematics, as a foundational component of engineering programs, plays a critical role in determining student progression and overall academic success. This study presents an Artificial Intelligence driven framework for predicting student success in engineering mathematics by integrating course performance data, academic progression patterns, and mathematical misconception indicators. Student achievement data collected over multiple academic years were analyzed using statistical and machine learning techniques. Correlation and regression analyses were first employed to investigate relationships between foundational and advanced mathematics courses. The analysis was then extended through the development of AI-based predictive models trained on student achievement records, progression histories, and misconception assessment results. Model performance was evaluated using standard classification and prediction metrics. The results revealed significant positive correlations between foundational and advanced mathematics courses, confirming the importance of strong mathematical foundations. The AI models effectively identified students at risk of poor academic outcomes with high predictive accuracy. Feature importance analysis depicted that prior mathematics achievement, progression history, and misconception scores were among the strongest predictors of future performance. Furthermore, while mathematical misconceptions exhibited a strong relationship with immediate course achievement, their influence on later mathematics courses was reduced, suggesting that many misconceptions are progressively corrected through higher education. Analysis of underperforming students also demonstrated that a substantial proportion improved in subsequent mathematics courses, highlighting the value of timely intervention and academic support.
The proposed framework demonstrates the potential of AI and learning analytics to support evidence based decision making, personalized interventions, and early warning systems. The findings contribute to the growing field of AI in Education and provide practical strategies for improving student success, progression, and retention in engineering programs.

Keywords: *Artificial Intelligence in Education, Learning Analytics, Student Success Prediction, Mathematical Misconceptions, Predictive Modeling, Educational Data Mining.*

1. Introduction

Mathematics is widely recognized as a cornerstone of engineering education, providing the analytical, computational, and problem-solving skills required for success in engineering disciplines. Performance in mathematics courses has been shown to influence achievement in subsequent engineering and technical courses, making mathematics a critical component of student progression and retention. Despite its importance, many engineering students experience difficulties in mathematics due to gaps in prior knowledge, misconceptions, ineffective learning strategies, and challenges in adapting to university-level learning environments.

With the increasing availability of educational data, learning analytics and Artificial Intelligence (AI) have emerged as promising approaches for understanding student learning behaviors and predicting academic outcomes. Educational institutions are increasingly seeking data-driven approaches to identify students at risk of poor academic performance and provide timely interventions before failure occurs. AI-driven predictive models offer opportunities to transform traditional academic support systems by enabling personalized learning pathways and early-warning mechanisms.

Previous studies have investigated the relationship between mathematics achievement and performance in engineering programs. However, limited research has combined course correlations, student progression patterns, and mathematical misconceptions within a unified AI-driven learning analytics framework. Furthermore, there remains a need to understand how misconceptions influence

future academic performance and whether student achievement in prerequisite mathematics courses can reliably predict success in higher-level courses.
This study addresses these gaps by investigating the relationships among mathematics course performance, progression patterns of underperforming students, and mathematical misconceptions. The study further develops AI-based predictive models to identify key indicators of future academic success. The findings aim to support educators in developing targeted interventions and evidence-based strategies for improving student progression, retention, and achievement in engineering education.

1.2 Literature Review

Student performance prediction has attracted significant attention in engineering and higher education research. Several studies have demonstrated that achievement in mathematics courses is strongly associated with academic success in engineering programs. Alahmad et al. [1] examined the relationship between student performance in Calculus I and Physics I and reported a significant association between mathematics achievement and performance in science-based engineering courses.
Thomas et al. [2] investigated the influence of university entry scores on engineering mechanics performance and found that students entering university with weaker academic preparation were at a substantially higher risk of failure. Similarly, Imran and Hayati [3] reported that mathematics achievement was a stronger predictor of overall engineering performance than science-based subjects, emphasizing the critical role of mathematical competence in engineering education.
Beyond course performance, researchers have highlighted the importance of understanding student misconceptions. Weliwita et al. [4] conducted a statistical analysis of mathematical misconceptions among engineering students and demonstrated that misconceptions significantly influence student achievement. Their work further suggested that targeted pedagogical interventions can improve conceptual understanding and academic outcomes. In a related study, Weliwita and Witharana [5] emphasized the role of authentic learning and assessment practices in enhancing student engagement and improving learning outcomes in higher education.
The emergence of learning analytics and educational data mining has created new opportunities for understanding student learning processes. Siemens and Baker [6] highlighted the growing importance of learning analytics in transforming educational decision-making through data-driven approaches. Aldowah et al. [7] further demonstrated that educational data mining techniques can support early identification of at risk students and facilitate personalized interventions. Recent advances in Artificial Intelligence have extended these capabilities through predictive models capable of forecasting student performance and supporting proactive academic advising.
Despite these developments, relatively few studies have integrated course correlations, progression analysis, and misconception indicators within a single predictive framework for engineering mathematics. The present study addresses this gap by combining statistical analysis and AI-driven prediction to identify key factors influencing student success and progression in engineering mathematics courses.

2. Methodology

This study employed a combined learning analytics and Artificial Intelligence (AI) approach to investigate factors influencing student success in engineering mathematics. The methodology consisted of data collection, preprocessing, statistical analysis, AI model development, and model evaluation. The objective was to identify relationships among mathematics course performance, academic progression, and mathematical misconceptions, and to develop predictive models capable of identifying students at risk of poor academic performance.

2.1 Data Collection and Preprocessing

Student academic records were collected from engineering mathematics courses offered over 2019 to 2022. The dataset included student grades from foundational and advanced mathematics courses, progression records between courses, and results from a mathematical misconceptions assessment conducted among engineering students. Data from both male and female students were included to provide a comprehensive representation of student performance patterns. Prior to analysis, all student records were anonymized to ensure confidentiality and compliance with institutional data protection requirements. Missing or incomplete records were removed, and grade data were standardized to

enable meaningful comparison across different courses and academic years. The data were then organized into categories representing course performance, academic progression, and misconception assessment outcomes.

2.2 Statistical Analysis

Descriptive statistical techniques were used to analyze grade distributions and overall student performance trends. Correlation analysis was performed to examine relationships between foundational and advanced mathematics courses. Regression analysis was further conducted to quantify the strength of these relationships and identify factors associated with student achievement.
To investigate academic progression, students with low grades in prerequisite mathematics courses were tracked through subsequent courses. Grade transitions, progression patterns, and failure rates were analyzed to determine the extent to which early academic performance influenced future outcomes.

2.3 AI Based Prediction Model

Artificial Intelligence techniques were employed to predict student performance in advanced mathematics courses. Input variables included grades from prerequisite courses, progression history, and misconception assessment scores. Machine learning models were trained using historical student data to classify students according to their likelihood of academic success or risk of poor performance. The predictive performance of the AI models was evaluated using standard classification metrics, including accuracy, precision, recall, and F1 score. Confusion matrix analysis was also used to assess the effectiveness of the models in correctly identifying students at risk of academic difficulties. Feature importance analysis was conducted to determine the relative contribution of each predictor variable to model performance.

2.4 Research Framework

The proposed framework consisted of five stages: data collection, data preprocessing, statistical analysis, AI model development, and performance evaluation. The framework was designed to provide both explanatory insights into student learning patterns and predictive capabilities for early identification of at-risk students. The resulting system supports data-driven decision making and the development of targeted academic interventions aimed at improving student success, progression, and retention in engineering education.

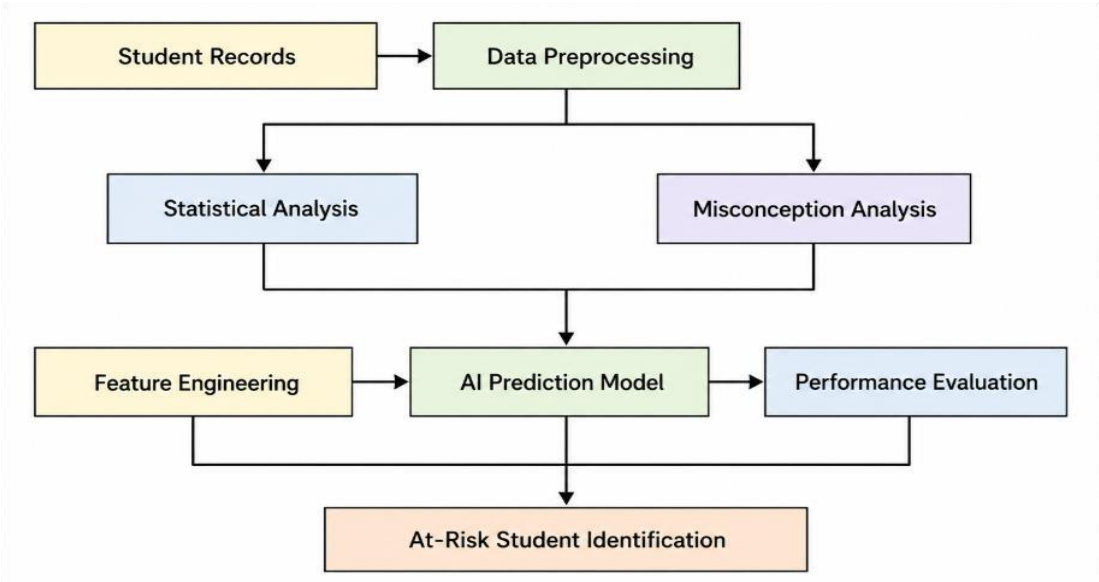


Fig. 1. AI-driven framework for predicting student success in engineering mathematics using student records, statistical analysis, feature selection, machine learning, and risk prediction.

3. Results And Discussion

3.1 Academic Progression Analysis

The progression patterns of students across mathematics levels were investigated to understand whether poor performance in earlier mathematics courses persisted throughout the curriculum. The analysis revealed that only a small proportion of students who obtained low grades in earlier mathematics levels continued to achieve similarly low grades in higher mathematics levels. In contrast, a substantial proportion of students demonstrated improved academic performance as they progressed through the curriculum.

As shown in **Fig. 2**, approximately 18% of students who performed poorly in an earlier mathematics level continued to obtain low grades in subsequent mathematics courses. However, more than 80% of students demonstrated improved performance, suggesting that early academic difficulties do not necessarily determine future achievement. These findings emphasize the importance of timely academic support and targeted interventions.

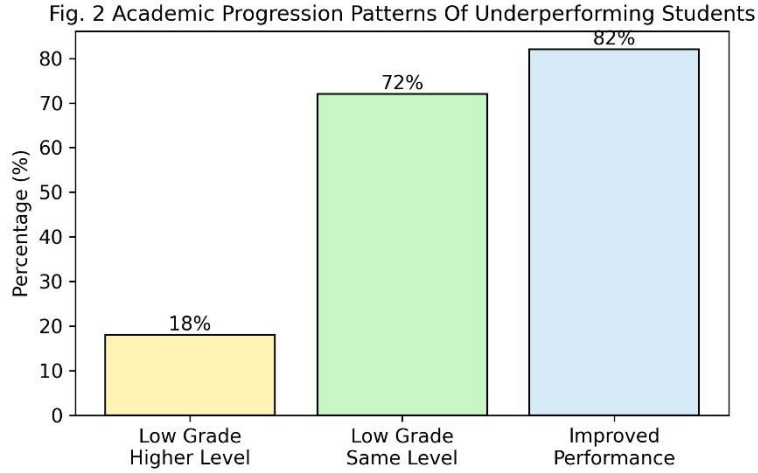


Fig. 2. Academic Progression Patterns of Underperforming Students

3.2 Correlation Between Mathematics Levels

To examine the relationship between mathematics courses, correlation analysis was conducted using student achievement data across four mathematics levels. The resulting correlation matrix is presented in Fig. 3. The analysis revealed strong positive correlations between adjacent mathematics levels. The highest correlation was observed between Level 2 and Level 3 ($r = 0.81$), followed by Level 3 and Level 4 ($r = 0.79$), and Level 1 and Level 2 ($r = 0.78$). A moderate correlation was observed between Level 1 and Level 4 ($r = 0.58$), indicating that the influence of foundational mathematics achievement gradually decreases as students progress through the curriculum.

These findings confirm that strong performance in foundational mathematics courses contributes significantly to future academic success and support the use of previous mathematics achievement as a predictor variable in AI-based learning analytics models.

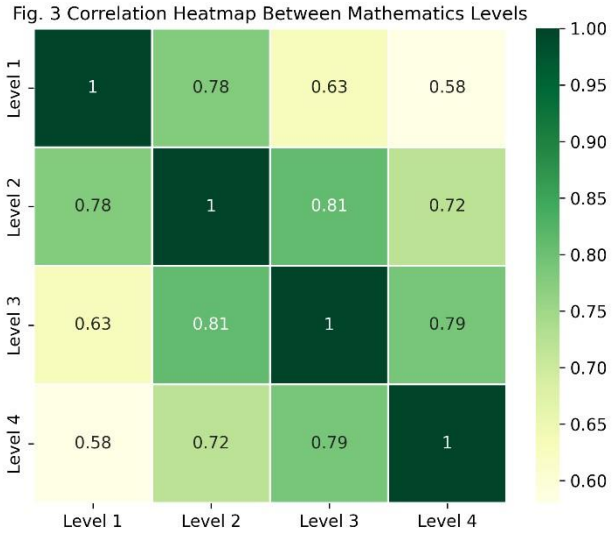


Fig. 3. Correlation Heatmap Between Mathematics Levels

3.3 Influence of Mathematical Misconceptions

The relationship between misconception scores and mathematics performance was examined using the misconception assessment data. As illustrated in Fig. 4, a clear negative relationship exists between misconception scores and academic achievement.

Students with higher misconception scores generally obtained lower grades in mathematics courses. The regression trend indicates that increasing misconceptions are associated with a reduction in overall performance. This finding is consistent with previous research, which identified misconceptions as a major contributor to poor academic outcomes in engineering mathematics.

The results suggest that misconception assessments can serve as valuable early indicators of students who may require additional support, particularly during the initial stages of their academic journey.

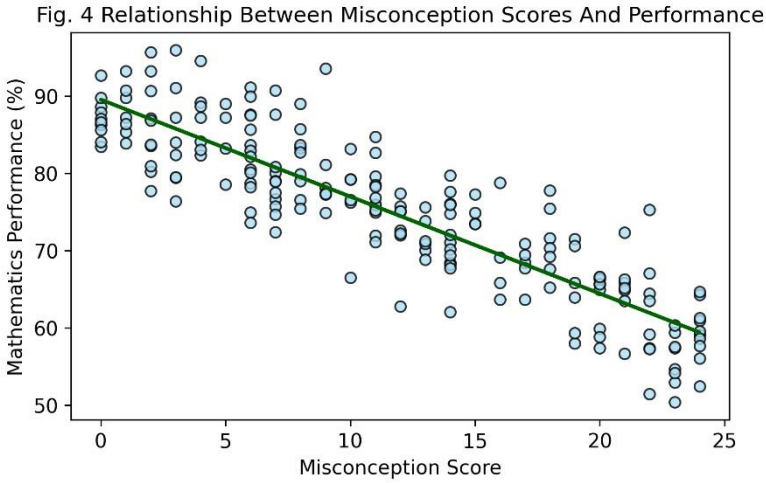


Fig. 4. Relationship Between Misconception Scores and Mathematics Performance

3.4 AI Based Prediction of Student Success

To evaluate the feasibility of early identification of at-risk students, an Artificial Intelligence framework was developed using a synthetic dataset generated from the statistical characteristics observed in the educational data. The generated dataset preserved progression patterns, misconception effects, and course correlations identified in the statistical analysis.

Several machine learning algorithms were evaluated, including Random Forest, Gradient Boosting, XGBoost, and Artificial Neural networks. Among the evaluated models, the Random Forest classifier achieved the highest predictive performance and was selected as the final model.

The confusion matrix of the best performing model is shown in Fig. 5. The model successfully identified the majority of both at risk and non at risk students, demonstrating the potential of AI techniques for supporting academic decision making and intervention planning.



Fig. 5. Confusion Matrix of The Best AI Model

3.5 Feature Importance Analysis

Feature importance analysis was performed to determine the variables contributing most significantly to student success prediction.

Table 1. Relative Importance of Predictive Features

Predictor	Relative Importance (%)
Previous Mathematics Achievement	42
Academic Progression History	25
Misconception Score	18
Semester Indicator	9
Mathematics Level	6

The analysis identified previous mathematics achievement as the most influential predictor, accounting for 42% of the predictive power of the model. Academic progression history and misconception scores were also important contributors. These findings reinforce the importance of foundational mathematics performance and conceptual understanding in determining future academic success.
Overall, the AI model achieved high predictive accuracy and demonstrated the potential of learning analytics for identifying at-risk students before academic difficulties become critical. The integration of mathematics achievement records, progression indicators, and misconception assessments provides a practical foundation for developing intelligent early-warning systems in engineering education.

3.6 Discussion and Conclusion

This study combined statistical analysis and Artificial Intelligence techniques to investigate factors influencing student success in engineering mathematics. The statistical analysis demonstrated that performance in earlier mathematics levels is strongly associated with achievement in subsequent mathematics courses. The positive correlations observed between mathematics levels indicate that foundational mathematical knowledge plays a critical role in supporting future academic progression.
The progression analysis provided an important insight into student learning trajectories. Although some students experienced difficulties in earlier mathematics courses, most improved their performance in subsequent mathematics levels. This finding suggests that poor performance at the beginning of a program does not necessarily predict long-term academic failure and highlights the importance of timely academic support and intervention strategies.
The misconception analysis further revealed that conceptual misunderstandings have a measurable impact on student achievement. Students with higher misconception scores generally obtained lower grades, confirming the importance of identifying and addressing misconceptions during the early stages of learning. As students progressed through the curriculum, the influence of misconceptions appeared

to decrease, suggesting that instructional interventions and learning experiences contribute to conceptual development.
Building upon these statistical findings, the AI-based predictive framework successfully identified students at risk of poor academic performance. Among the evaluated machine learning algorithms, the Random Forest model demonstrated the highest predictive performance. Feature importance analysis revealed that previous mathematics achievement, academic progression history, and misconception scores were the most influential predictors of future success.
The results demonstrate the potential of integrating learning analytics and Artificial Intelligence to support evidence-based decision making in engineering education. The proposed framework provides a practical foundation for developing intelligent early-warning systems capable of identifying at-risk students and enabling targeted interventions that improve student progression, retention, and academic success. Future work will focus on validating the framework using larger multi-institutional datasets and investigating advanced machine learning approaches to further enhance predictive accuracy and educational impact.

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Multiculturalism and Social Inclusion

Preschool Teachers' Professional Self-Efficacy in the Context of Linguistic Diversity: A Study from Olomouc

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Abstract

The growing linguistic diversity in early childhood education places new demands on the professional competencies of preschool teachers, their pedagogical decision-making, and their perceived professional confidence when working with children with a different mother tongue. This paper presents a section of a dissertation research project focused on the professional self-efficacy of preschool teachers in the context of linguistic diversity. The aim of the research was to determine how preschool teachers in Olomouc assessed their own professional self-efficacy when working with children with a different mother tongue, with an emphasis on professional competencies. Theoretically, the article is based on Albert Bandura's social-cognitive concept of self-efficacy, the concept of teacher self-efficacy, and the framework of inclusive and language-aware pedagogy. The research was conducted via an online questionnaire survey. The questionnaire focused on four areas: language support, working with the child's mother tongue, pedagogical practice, and the child's social inclusion. The research sample consisted of 11 respondents from kindergartens in Olomouc. Given the limited size of the research sample, the findings were interpreted descriptively and exploratively. The findings indicated a higher level of professional confidence in the areas of visual communication, everyday pedagogical practice, and the child's social inclusion, while a lower level of self-efficacy was observed in the area of actively working with the child's mother tongue as a pedagogical resource.

Keywords: *self-efficacy; preschool education; different mother tongue; linguistic diversity; inclusive education; research study*

1. Introduction

Linguistic diversity is becoming an increasingly significant pedagogical issue in contemporary early childhood education. Preschools more frequently encounter children whose mother tongue or home language differs from the language of education. This situation affects not only the child's language development, but also adaptation, social inclusion, peer communication, sense of safety and overall participation in the everyday life of the classroom. A child with a different mother tongue should therefore not be viewed only as a child with insufficient knowledge of Czech, but as a child entering a new linguistic, cultural and social environment.

Preschool teachers play a crucial role in this process. Their pedagogical action may significantly influence whether linguistic difference is perceived as an obstacle or as a natural part of a diverse educational environment. At the same time, teachers face a range of specific professional demands: they need to adapt communication, use visual support, create comprehensible learning situations, support peer relationships, cooperate with parents and respond to the child's emotional needs. It is therefore important to examine not only the needs of children with a different mother tongue, but also how teachers perceive their own capacity to manage such situations.

This paper is based on broader doctoral research focused on preschool teachers' professional self-efficacy in the context of linguistic diversity. While the doctoral project is designed within a broader comparative perspective of the Czech Republic and Finland, this paper focuses on a partial quantitative component carried out in Olomouc. The aim of the paper is to present findings on how preschool teachers evaluate their own professional confidence when working with children with a different mother tongue.

2. Theoretical Background

The concept of self-efficacy is grounded in Albert Bandura's social cognitive theory. Self-efficacy refers to an individual's belief in their capacity to organise and execute the actions required to manage specific situations [1]. It is therefore not a general sense of self-confidence, but a context- and task-specific

belief. In the pedagogical environment, this means that a teacher may feel highly confident in one area of her work, such as organising routine activities, but less confident in situations requiring support for a child with a different mother tongue.
Bandura emphasises that self-efficacy influences how people think, act, motivate themselves and cope with challenging situations [1]. A higher level of perceived efficacy supports persistence, willingness to overcome obstacles and the ability to perceive difficult tasks as challenges. Conversely, lower self-efficacy may lead to avoidance of demanding situations or to giving up more quickly when difficulties arise. In the context of working with children with a different mother tongue, the concept is particularly relevant because teachers often act in situations requiring pedagogical flexibility, non-verbal support, visualisation, cooperation with the family and sensitive work with the group.
In the teaching profession, the term teacher self-efficacy is used to describe teachers' beliefs in their ability to support children's learning and engagement, including in pedagogically demanding situations [2]. Tschannen-Moran and Woolfolk Hoy also point out that teacher self-efficacy is associated with persistence, professional commitment, organisation of pedagogical work, openness to new methods and teachers' classroom behaviour [2]. In relation to linguistic diversity, it is therefore important to ask whether teachers feel able to seek and use strategies that enable a child with a different mother tongue to understand, participate and experience success.
An important framework for measuring teacher efficacy in inclusive education is the Teacher Efficacy for Inclusive Practices scale (TEIP). Sharma, Loreman and Forlin developed an 18-item instrument measuring teachers' perceived efficacy in implementing inclusive practices [3]. The original scale distinguishes three areas: efficacy in inclusive instruction, efficacy in collaboration and efficacy in managing behaviour [3]. This framework is relevant to the present research because work with a child with a different mother tongue also requires specific inclusive strategies, cooperation and pedagogical decision-making in everyday situations.
In the Czech preschool context, a child with a different mother tongue is a child whose first language differs from the language of education. This may include a child with a migration background, a child from a multilingual family or a child with insufficient knowledge of Czech for full participation in educational situations. Specialists point to difficulties that these children may face in preschools, particularly in understanding a new environment and in communicating with teachers and peers [4]. Support for the child is connected with the acquisition of Czech, gradual adaptation, meeting the need for safety, socialisation and close cooperation between the family and the school [4].
Language-aware pedagogy is another important concept for working with linguistically diverse groups. It is based on the assumption that language is present in all areas of learning and that every teacher participates in supporting the child's language development. Research by Alisaari et al. shows that teachers may hold generally positive attitudes towards multilingualism, yet may not always understand children's mother tongues as an active resource for learning [5]. The authors draw attention to persistent monolingual assumptions and the need for professional development in linguistically responsive strategies [5]. An inspirational framework in this respect is provided by the Finnish National Core Curriculum for Early Childhood Education and Care, which emphasises cultural diversity and language awareness as part of the educational culture [6].
In the Czech context, work with language, communication, adaptation and social inclusion is a natural part of early childhood education. The Framework Educational Programme for Preschool Education defines the basic principles, conditions and rules for institutional education of preschool-aged children [7]. For work with children with a different mother tongue, areas connected with language and speech, socialisation, cultural awareness, cooperation with the family and the creation of conditions for individualised support are particularly significant.

3. Research Aim and Research Questions

The aim of the research study was to examine how preschool teachers in Olomouc perceived their own professional self-efficacy when working with children with a different mother tongue and to identify the areas in which they felt more or less professionally confident.
This aim was formulated in the context of the concept of self-efficacy, grounded in Albert Bandura's social cognitive theory, according to which an individual's beliefs about their own capabilities significantly influence motivation, action, persistence and coping with challenging situations. In pedagogical practice, the level of teachers' professional self-efficacy may influence their approach to working with children with a different mother tongue, their choice of pedagogical strategies and their ability to respond to these children's specific educational needs.

3.1 Research Problem

Are preschool teachers equipped with the professional competences necessary for working with children with a different mother tongue?

3.2 Main Research Question

How do preschool teachers in Olomouc perceive their own professional self-efficacy when working with children with a different mother tongue?

3.3 Specific Research Questions

1. In which areas of work with children with a different mother tongue do teachers feel most professionally confident?
2. In which areas do teachers experience the lowest level of professional confidence?
3. What factors, according to teachers, influence their professional self-efficacy when working with children with a different mother tongue?
4. How do teachers evaluate their preparedness for working with children with a different mother tongue?

4. Methodology

The research study was exploratory in character. Its aim was not to statistically generalise the results to the population of preschool teachers, but to provide an initial insight into perceived professional self-efficacy in a specific local context. Methodologically, it was a questionnaire survey, and the data were analysed using descriptive statistics. Such an approach is appropriate in pedagogical research particularly for the basic description of the research sample and for initial orientation within the studied phenomenon [8], [9].

The research sample consisted of 11 teachers from selected preschools in Olomouc. The selection was based on criterion sampling. The inclusion criteria were: qualification in preschool pedagogy, experience of working with children with a different mother tongue or knowledge of the issue, and employment in a preschool in Olomouc. All included respondents corresponded to the geographical delimitation of the study. Participation was voluntary and anonymous; the results were presented only in aggregated form.

The respondents ranged in age from 21 to 53 years, with a mean age of 32.4 years. Eight respondents worked in public preschools and three in private preschools. In terms of length of teaching experience, both beginning teachers and teachers with longer professional experience were represented. Four respondents reported 0-3 years of experience, four reported 4-10 years, two reported 11-22 years and one reported 21 years or more. Nine respondents reported current experience with a child or children with a different mother tongue in their classroom, while two respondents did not currently have a child with a different mother tongue in their class.

In terms of previous preparation for working with children with a different mother tongue, five respondents stated that they had not completed any training. Two respondents reported self-study, two reported a one-off training course or seminar, one respondent reported training as part of university studies and one reported a combination of several forms of education. The characteristics of the sample therefore indicate diversity in both professional education and teachers' experience.

This text represents a partial output of the doctoral project. The research will subsequently be expanded within the Czech Republic, and the collected data will be compared with research being prepared in Finland.

Table 1. Characteristics of the Research Sample

Characteristic	Result
Number of respondents	11
Age of respondents	21-53 years
Mean age	32.4 years
Public preschool	8
Private preschool	3
Currently has a child/children with a different mother tongue in the class	9
Does not currently have a child/children with a different mother tongue in the class	2
No completed training related to children with a different mother tongue	5
Self-study	2

Characteristic	Result
One-off training course/seminar	2
Training as part of university studies	1
Combination of several forms of education	1

4.1 Research Instrument

The questionnaire was created as an author-adapted research instrument based on the theoretical framework of teacher self-efficacy, inclusive pedagogy and language-aware pedagogy. Its construction was inspired, among other sources, by the Teacher Efficacy for Inclusive Practices scale, which focuses on teacher efficacy in inclusive instruction, collaboration and classroom management [3]. The questionnaire items were adapted to the specific conditions of preschool education for children with a different mother tongue.

The questionnaire included items focusing on respondents' basic characteristics, experience with children with a different mother tongue, completed training in this area, perceived support from the school and professional self-efficacy when working with children with a different mother tongue. The core of the questionnaire consisted of items rated on a six-point scale, where 1 indicated the lowest level of professional confidence and 6 the highest. The items were thematically divided into four areas: language support, work with the child's mother tongue, pedagogical practice and social inclusion.

Given the size of the research sample, neither factor analysis nor testing of the internal consistency of individual scales was conducted. The data were analysed using descriptive statistics, particularly means, medians, minimum and maximum values. An open-ended question was used as an additional orientating source for interpreting the quantitative findings. Before the analysis, the completeness and factual correctness of the responses were checked.

5. Analysis, Evaluation and Interpretation of Data

Given the size of the research sample, the results were interpreted descriptively. The aim was not to test statistically significant relationships between variables, but to obtain an overview of how preschool teachers in Olomouc evaluated their professional self-efficacy when working with children with a different mother tongue.

The core of the questionnaire consisted of items focused on four thematic areas of professional self-efficacy: language support, work with the child's mother tongue, pedagogical practice and social inclusion. Respondents rated individual items on a six-point scale, where 1 indicated the lowest level of professional confidence and 6 the highest. The overall mean score across all items was 4.23, indicating a rather higher level of perceived professional confidence. However, the results differed substantially across the individual areas.

The highest mean scores were found in the areas of language support, social inclusion and pedagogical practice. By contrast, considerably lower scores appeared in the area of working with the child's mother tongue. This difference suggested that the respondents felt relatively more confident in common pedagogical strategies, visual support, adapting communication and supporting social inclusion, but less confident in actively using the child's mother tongue as a pedagogical resource.

Table 2. Descriptive Statistics of Professional Self-Efficacy by Thematic Area

Area	Mean score	Median	Min.-max.
Language support	4.71	4.40	3.60-5.80
Social inclusion	4.69	4.60	3.80-6.00
Pedagogical practice	4.53	4.40	3.40-5.60
Child's mother tongue	2.98	3.00	1.40-5.60

In the area of language support, respondents achieved the highest mean score of all the observed areas. The highest confidence was reported for the item concerning the use of gestures, pictures or visual demonstrations to support understanding. The mean score for this item was 5.09. Relatively high values were also recorded for the ability to support a child with a different mother tongue in understanding everyday situations in preschool and for the ability to recognise that a child does not understand because of a language barrier.

In the area of pedagogical practice, the mean score was 4.53. Respondents felt most confident in using strategies that support children with a different mother tongue, such as repetition, visualisation and cooperation among children. High scores also appeared for the ability to involve children with different

levels of language skills in joint activities. A slightly lower, though still positive, evaluation was recorded for the ability to adapt the educational offer so that a child with a different mother tongue can participate. In the area of social inclusion, the mean score was 4.69, the second highest of the observed areas. The highest rating appeared for the item "I can help a child feel safe in the classroom despite a language barrier", where the mean reached 5.00. Respondents also rated relatively highly their ability to recognise the child's emotional needs related to the language barrier, involve the child in play and prevent exclusion from the group.

At the level of thematic areas, the lowest mean score was identified in the area of working with the child's mother tongue (M = 2.98). This value was substantially lower than the mean scores recorded in the other observed areas. At the level of individual items, the lowest mean values within this area were found for the items "I can support the development of the child's mother tongue while the child is learning Czech" (M = 2.55) and "I can support the child in using their mother tongue in natural situations" (M = 2.64). The item "I can use the child's mother tongue as support for learning, even if I do not speak the language myself" reached a mean score of 2.82. Therefore, the value 2.98 refers to the overall thematic area, whereas the lower values refer to individual questionnaire items.

Table 3. Highest and Lowest Rated Items

Item	Area	Mean score
I can use gestures, pictures or visual demonstrations to support understanding	Language support	5.09
I can help a child feel safe in the classroom despite a language barrier	Social inclusion	5.00
I can support a child with a different mother tongue in understanding everyday situations in preschool	Language support	4.82
I can use strategies that support children with a different mother tongue	Pedagogical practice	4.73
I can support the development of the child's mother tongue while the child is learning Czech	Child's mother tongue	2.55
I can support the child in using their mother tongue in natural situations	Child's mother tongue	2.64
I can use the child's mother tongue as support for learning, even if I do not speak the language myself	Child's mother tongue	2.82

The supplementary open-ended question focused on what helped respondents most when working with children with a different mother tongue. Due to the scope of the study, the responses were not subjected to full qualitative analysis, but they were used as an orientating complement to the quantitative findings. The most frequent themes were visualisation, picture material, gestures, repetition, an individual approach, a safe environment, cooperation with parents and support from another person. Respondents mentioned, for example, pictures, cards, visual aids, a translator, repetition, gestures, cooperative parents and a kind relationship built gradually with the child.

The open-ended responses provided additional support for the quantitative findings. Teachers most often reported practical and situationally usable strategies that help the child understand the environment and participate in activities. Work with the child's mother tongue as a systematic part of pedagogical support appeared less frequently in the responses. This finding is consistent with the lower score in the area focused on the child's mother tongue.

Overall, the findings indicated that respondents showed a rather higher level of professional self-efficacy in areas connected with everyday pedagogical practice, visual communication and support for social inclusion. By contrast, working with the child's mother tongue appeared to be a weaker area, especially its active use as a support for learning and the simultaneous development of the mother tongue and Czech.

6. Discussion

The findings should be interpreted with regard to the exploratory character of the study and the limited size of the research sample. On the basis of teachers' self-evaluation in selected preschools, it can be stated that there was a difference between relatively higher professional confidence in visual communication, pedagogical organisation and the child's social inclusion, and lower confidence in actively working with the child's mother tongue.

This result corresponds to the theoretical assumption that self-efficacy is a context- and task-specific construct. A teacher may feel competent in routine pedagogical situations, but less confident in tasks

requiring specific knowledge and strategies. In the case of children with a different mother tongue, professional confidence may therefore relate not only to a general ability to support the child, but also to specific areas such as working with linguistic diversity, using the child's mother tongue, communicating with parents or consciously supporting the child's multilingual identity.
The finding that teachers felt most confident in using gestures, pictures, visual demonstrations and other situational supports may be understood as a reflection of the nature of early childhood education. Pedagogical work in preschool is naturally based on activity, play, repetition, routines and immediate interaction. These elements may provide teachers with relatively accessible strategies for supporting children who do not yet fully understand the language of education.
Similarly, the higher mean score in the area of social inclusion indicated that respondents perceived the support of safety, relationships and participation in play as an area they could influence pedagogically. This aspect is essential in early childhood education because a sense of safety and the opportunity to establish peer relationships create conditions for further learning, communication and language development.
However, the lowest level of self-efficacy in the area of working with the child's mother tongue indicated, within the selected sample, the need to strengthen further education in this area. The results of self-evaluation suggested that teachers' intuition may play an important role, but that it should be supported by professional knowledge. The findings indicated that teachers may find it difficult to imagine how the child's mother tongue can be used as a pedagogical resource, especially if they do not speak the language themselves. This is consistent with international research showing that teachers may hold generally positive attitudes towards multilingualism, but may not always actively use children's home languages as part of the educational process [5].
The data also suggested that teachers' knowledge of a foreign language did not necessarily have to be the only or main prerequisite for professional confidence when working with children with a different mother tongue. More important is the ability to create a comprehensible, safe and inclusive environment, work with non-verbal and visual support, support peer relationships and cooperate with the family. Nevertheless, the question remains how to help teachers move beyond compensatory strategies and develop approaches that understand the child's mother tongue as part of their identity and as a potential resource for learning.
From a methodological perspective, the adapted questionnaire appeared to be a suitable research instrument for broader use in subsequent phases of the research. The thematic division into language support, the child's mother tongue, pedagogical practice and social inclusion made it possible to capture differences between individual areas of professional self-efficacy. The area of working with the child's mother tongue proved to be particularly research-sensitive, as it clearly differed from the other areas by a lower level of declared professional confidence.

7. Limitations of the Research Study

The main limitation of the study was the small number of respondents in connection with the local delimitation of the research. The results therefore cannot be generalised to the population of preschool teachers in the Czech Republic, but can only be related to teachers from selected preschools in Olomouc. The findings had the character of a partial empirical insight that directs subsequent phases of the research. In a follow-up study, it will be necessary to expand the research sample so that the collected data have greater explanatory value for the field of early childhood education in the Czech Republic.
Another limitation was that the data were based on respondents' self-evaluation. Declared professional confidence may not always correspond to actual pedagogical action in specific situations. Responses may have been influenced by respondents' current experience with children with a different mother tongue, the level of support in the school, previous training and subjective perceptions of their professional role. In the next phase of the research, it therefore appears appropriate to supplement the quantitative data with qualitative procedures enabling a deeper understanding of the perspectives of teachers, families and children themselves.

8. Conclusion

This paper presented the results of an exploratory study focused on preschool teachers' professional self-efficacy when working with children with a different mother tongue. The findings showed that respondents in the research sample demonstrated a rather higher level of professional confidence in the areas of language support, everyday pedagogical practice and the child's social inclusion. The

highest values appeared for items connected with the use of gestures, pictures, visual demonstrations and support for the child's sense of safety in the classroom.
By contrast, the lowest level of professional confidence was identified in the area of working with the child's mother tongue. This result suggested that teachers may be able to support a child with a different mother tongue through visual, social and organisational strategies, but feel less confident in actively using the child's mother tongue as a pedagogical resource. This area therefore appears to be an important space for further methodological support, professional education and the development of language-aware pedagogy in preschools.
The significance of the study lies primarily in capturing a partial picture of preschool teachers' professional self-efficacy in a selected region and in identifying areas that may be significant for subsequent phases of the doctoral research. The findings provide a basis for expanding the research to a broader sample of respondents and for supplementing the research with additional instruments, particularly interviews and observation.

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Adult Education, Social Selectivity and Inclusion: Evidence from Slovenia and Implications for Deinstitutionalisation

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Abstract

Adult education is widely promoted as a driver of personal development, social mobility and labour-market adaptability; however, participation in lifelong education and learning remains uneven. This paper examines factors associated with participation in formal and non-formal adult education in Slovenia, with a focus on social inclusion and barriers affecting disadvantaged groups. Using Labour Force Survey (LFS) data and binary logistic regression, we test how individual, educational, occupational and spatial characteristics predict participation. The results show marked social selectivity: women participate more than men; participation decreases with age; and people with higher educational attainment participate substantially more. Participation is also higher among those in managerial roles or on fixed-term contracts, while people born abroad and those living outside large cities are less likely to participate. Descriptive evidence additionally indicates a substantial participation gap by disability status. Building on these findings, we discuss a possible intersectoral approach to inclusion in the context of deinstitutionalisation in Slovenia, focusing on how existing community-learning infrastructures, such as SIAE Study Circles and selected programmes delivered by adult education centres (Folk high schools), could support participation in community life. Because outcomes are not yet known, this approach is presented as a practice-based proposal that would require monitoring and evaluation during any future implementation. A compassion-centred lens (awareness, compassion, loving-kindness and wisdom) is proposed as an enabling condition for sustainable cross-sector cooperation between social protection, adult education and local communities.
Keywords: adult education; participation inequalities; inclusion; deinstitutionalisation; people with disabilities; cross-sector cooperation

1. Introduction

Adult education and lifelong learning are widely promoted as pathways to personal development, employability and social inclusion. However, participation remains unequally distributed across social groups. The core policy challenge is therefore not only how much adults learn, but who participates and who is systematically left out.

Participation in education tends to follow identifiable social patterns: it often reflects accumulated advantages in cultural and social capital, confidence in navigating institutions and the ability to convert resources into learning opportunities. From this perspective, adult education can function as a selective field, reproducing inequalities unless compensatory mechanisms reduce barriers for those with fewer resources [1]. Participation in adult education is also shaped by barriers and constrained choices ("bounded agency") embedded in welfare regimes and social contexts [2-4]. This means that participation is not only a question of personal motivation. People who already have more education, support, information and confidence are more likely to use learning opportunities, while those with fewer resources may remain excluded because of practical, social or institutional barriers.

To examine participation inequalities empirically, we analyse Slovenian Labour Force Survey / Survey on Active and Inactive Population (LFS/ANP) data using binary logistic regression. We model how individual (gender, age), educational, occupational and spatial characteristics jointly shape the probability of participation in formal or non-formal education during the four weeks preceding the survey [5].

A critical extension of this discussion concerns people with disabilities. Lower participation in adult education is not only an educational outcome; it can also signal weaker access to social networks, community routines and low-threshold public spaces where belonging is built. This is especially relevant

when disability intersects with other exclusion risks such as lower education, rural residence or being born abroad.
Participation inequalities acquire additional urgency in Slovenia's ongoing deinstitutionalisation. The national strategy aims to support transitions from institutional care to community living while strengthening community support structures and preventing new institutional placements [6]. International guidance emphasizes that relocation alone is insufficient: inclusion requires access to mainstream services and facilities, including education, culture and leisure, on an equal basis with others [7-8].
In practical terms, successful community living requires more than housing and formal support. People transitioning from institutional settings often need meaningful activities, opportunities for social learning and accessible entry points into local community life. Instead of creating parallel programmes from scratch, we discuss a possible practice-based link between adult education and deinstitutionalisation, focusing on how existing community-learning structures, particularly SIAE Study Circles and selected programmes delivered by adult education centres (Folk high schools), could support meaningful participation in community life [9]. As outcomes are not yet known, this approach is presented as a feasible option to be monitored and evaluated during any future implementation. The partnership behind this paper reflects the idea that inclusion requires both evidence and the conditions that make practice possible. SIAE contributes the empirical adult-education research presented in this paper, together with trusted community-learning infrastructure through Study Circles. IRSSV brings knowledge of deinstitutionalisation and community-based support. The Inner Peace Institute contributes NGO-based facilitation approaches grounded in the contemplative tradition described by Dahl and Yongey Mingyur Rinpoche, where awareness, compassion, loving-kindness and wisdom are understood as trainable capacities for reducing harm and cultivating prosocial action [10-11]. These capacities are increasingly relevant in civil-society practice, where inclusion depends not only on services and structures, but also on the quality of relationships, attention and presence. Conceptually, we therefore treat inclusion as more than service coordination: it requires recognition of interdependence and an orientation toward the common good, understood as promoting 'good for all' and reducing harm. This brings into the discussion an often-overlooked dimension of inclusive practice: the inner conditions through which people, professionals and communities, become able to meet one another differently. Slovene educational scholarship similarly frames education as formation for responsible action and belonging, not only as measurable performance, especially in times of disruption [12-13]. Ethical codes in education emphasize respect, dignity and non-harm as professional obligations, resonating with the need for non-judgmental facilitation when people rebuild community life after institutionalisation [14-15]. Reflections on "overlooked time" further highlight patience and slowness as resources for learning and relationship-building [16]. Building on these perspectives, a compassion-centred lens is introduced as an enabling condition for sustained cross-sector cooperation and for the gradual transformation of institutional habits into relations of trust, participation and shared community life [10-11,17].
Objectives of the paper are to: (1) test whether participation in adult education in Slovenia can be predicted from individual, educational, occupational and spatial characteristics using LFS/ANP data and binary logistic regression; (2) demonstrate social selectivity of participation by identifying groups with systematically lower participation; and (3) discuss implications for inclusion of people with disabilities in the deinstitutionalisation process and outline a possible intersectoral approach to inclusion that draws on SIAE Study Circles as community-learning infrastructure and would require monitoring and evaluation during any future implementation.

2. Data and Methods

The paper adopts a combined methodological approach. The quantitative part analyses Labour Force Survey / Survey on Active and Inactive Population data using binary logistic regression to identify social patterns in participation in adult education. The second part is practice-based and conceptual rather than evaluative. It uses the empirical findings as a starting point for discussing why participation inequalities matter in the context of deinstitutionalisation, what deinstitutionalisation means and does not mean, and how existing community-learning infrastructures could support inclusion in community life. This design enables the paper to connect statistical evidence on unequal participation with a broader discussion of community living, access to mainstream services and the conditions needed for inclusive practice.

2.1 Data Source and Sampling

The empirical analysis is based on secondary data from the Survey on Active and Inactive Population (ANP), which in Slovenia is conducted in accordance with the harmonized methodology of the European Labour Force Survey (LFS). The sampling design is stratified, and data is collected using standardized procedures, ensuring comparability across EU Member States. For the purposes of this analysis, the analytical sample was restricted to the adult population aged 25 to 64. For model estimation, age groups include 15–24 as the reference category; therefore, the logistic regression uses the full 15–64 dataset, while descriptive indicators follow standard EU reporting for ages 25–64.
Participation in education is measured using the standard LFS indicator, which includes involvement in formal or non-formal education during the four weeks preceding the survey. The analytical sample does not include individuals living in institutional settings, as these are not covered by the survey sampling frame.

2.2 Operationalisation of Variables and Analytical Approach

The dependent variable is participation in adult education, operationalised as a binary variable distinguishing between individuals who participated in formal and/or non-formal education during the reference period (1 = participates) and those who did not (0 = does not participate). This operationalisation allows for direct modelling of the likelihood of participation in adult education.
Independent variables are selected based on prior empirical and theoretical research on social selectivity in adult education and include gender, age groups, educational attainment, country of birth, labour market status, type of employment, managerial role, and degree of urbanisation.
Where available, indicators of disability-related status are also considered descriptively as an additional dimension relevant for understanding risks of exclusion, particularly in the context of disability and deinstitutionalisation, although they are not included as a central component of the regression model.
The analysis combines descriptive and inferential statistical approaches. First, descriptive statistics are used to present basic patterns of participation. This is followed by binary logistic regression to model the probability of participation in adult education. Results are reported using regression coefficients (B), standard errors, Wald statistics, significance levels (p-values), and odds ratios (Exp(B)), allowing for substantive interpretation in terms of relative likelihoods of participation.
The model is statistically significant (χ^2 (12) = 2508.36, $p < .001$), indicating that the set of predictor variables reliably distinguishes between participants and non-participants. The explanatory power of the model is moderate, with Cox & Snell $R^2 = .127$ and Nagelkerke $R^2 = .187$.
The working-age sample (15–64) includes 30,041 respondents, while the standard EU benchmark sample (25–64) includes 24,784 respondents. The logistic regression model was estimated on the full 15–64 sample to retain the reference group aged 15–24 (often in initial education) and to illustrate the benchmark gap between those in regular education and adults; interpretive emphasis, however, is placed on the adult population.

2.3 Linking Participation Inequalities to Deinstitutionalisation

In addition to the quantitative analysis, the paper includes a practice-based and conceptual component that links the findings on participation inequalities to the context of deinstitutionalisation in Slovenia. This component does not evaluate an existing intervention and does not claim proven effectiveness. Rather, it discusses how the observed patterns of unequal participation may become relevant for people transitioning from institutional care to community living.
The discussion first clarifies deinstitutionalisation as more than relocation from institutions to smaller settings. It understands deinstitutionalisation as a broader transformation that requires access to ordinary community life, mainstream services, meaningful activities, social relationships and opportunities for participation. On this basis, the paper considers how existing adult-education and community-learning structures, particularly SIAE Study Circles and selected programmes delivered by adult education centres (Folk high schools), could serve as accessible entry points into local community life.
Methodologically, this component serves as an applied bridge between empirical findings and practice. The regression results identify groups at higher risk of non-participation, while the deinstitutionalisation discussion shows why such patterns matter for inclusive community living. Any practical use of these ideas would need to be monitored and evaluated during future implementation.

2.4 Limitations

The study does not include individuals living in institutional settings, which limits the direct empirical analysis of populations central to deinstitutionalisation processes. The practice-based component represents a conceptual and practice-oriented extension of the empirical findings. It is understood as a possible approach for further development, whose outcomes would need to be monitored and evaluated, rather than as an empirically validated solution. A further limitation is that the headline participation indicator is reported for ages 25–64, whereas the regression model includes ages 15–64 in order to retain the 15–24 reference category; this choice should be considered when interpreting age effects.

3. Results

3.1 Descriptive Patterns

Slovenia recorded a relatively high participation rate in adult education in 2024, with 23.1% of adults aged 25–64 engaged in formal or non-formal learning activities [5]. This places the country well above the EU-27 average (13.5%) and among the better-performing European systems. At an aggregate level, this suggests a comparatively strong foundation for lifelong learning.

However, aggregate performance masks substantial inequalities. Nearly 80% of adults did not participate in education or training during the observed period, indicating uneven access and engagement. Moreover, Slovenia still lags leading Nordic countries, where participation is both higher and more systematically embedded in institutional frameworks. This suggests that participation remains unevenly distributed and partly dependent on short-term or project-based initiatives rather than a fully consolidated lifelong learning system.

Descriptive patterns further indicate variation across key socio-demographic and structural characteristics, including age, education, labour market position, and place of residence, pointing to the presence of systematic participation gradients.

3.2 Main Logistic Regression Model

To examine these patterns more systematically, a binary logistic regression model was estimated to identify predictors of participation in adult education. The dependent variable captures participation in formal or non-formal education, while independent variables include gender, age, education, country of birth, employment characteristics, degree of urbanisation, and managerial responsibility.

Table 1. Logistic Regression Results

Predictor	B	SE	Wald χ^2	df	p	OR
Gender						
Female (ref. male)	0.221	0.037	34.81	1	< .001	1.25
Age (ref. 15–24)						
25–34	-1.336	0.074	325.70	1	< .001	0.26
35–44	-1.561	0.076	426.16	1	< .001	0.21
45–54	-1.637	0.075	481.69	1	< .001	0.20
55–64	-1.910	0.081	562.46	1	< .001	0.15
Education (ref. less than secondary)						
Secondary	0.439	0.096	21.12	1	< .001	1.55
Tertiary	1.390	0.098	202.33	1	< .001	4.02
Country of birth						
Born abroad (ref. Slovenia)	-0.496	0.069	52.17	1	< .001	0.61
Employment status						
Fixed-term (ref. permanent)	1.104	0.059	345.45	1	< .001	3.02
Degree of urbanization (ref. large city)						
Small town	-0.294	0.050	34.76	1	< .001	0.75
Rural area	-0.236	0.048	23.85	1	< .001	0.79

Predictor	B	SE	Wald χ^2	df	p	OR
Managerial responsibility						
No managerial duties (ref. managerial role)	-0.291	0.045	41.85	1	< .001	0.75
Constant	-0.578	0.116	24.65	1	< .001	0.56

Note. OR = odds ratio (Exp(B)). Reference categories are shown in parentheses. All p-values are based on Wald tests.

The model confirms that all included predictors are statistically significant ($p < .001$), indicating that participation is strongly structured by socio-demographic and labour-market factors.
Age emerges as the most pronounced predictor. Because the 15–24 reference group includes many individuals in initial education, this comparison should be read as a benchmark; within the adult population (25–64), participation still declines with age. Compared to the youngest group (15–24), the odds of participation decline sharply across all older age groups (OR = 0.26 to 0.15), reflecting a clear life-course gradient. Educational attainment is another key determinant: individuals with secondary education are more likely to participate than those with lower education (OR = 1.55), while tertiary-educated individuals exhibit substantially higher odds (OR = 4.02), indicating cumulative advantage in access to learning.
Gender differences are present but more moderate, with women showing slightly higher odds of participation than men (OR = 1.25). Being born abroad is associated with lower participation (OR = 0.61), suggesting structural barriers linked to migration background.
Labour-market characteristics further reinforce these patterns. Individuals with fixed-term contracts are significantly more likely to participate than those with permanent employment (OR = 3.02), which may reflect activation mechanisms or employment-related incentives. In contrast, individuals without managerial responsibilities show lower participation (OR = 0.75), pointing to the role of workplace context and job complexity.
Spatial disparities are also evident. Compared to residents of large cities, individuals living in small towns (OR = 0.75) and rural areas (OR = 0.79) have lower odds of participation, indicating the importance of local availability and accessibility of learning opportunities.
Overall, the model demonstrates that participation in adult education is not randomly distributed but follows clear structural patterns that reflect accumulated advantages and constraints.

3.3 Disability-related Participation Gap

Although disability is not included as a central predictor in the regression model, descriptive evidence reveals a strong participation gradient by level of disability. Adults without disabilities participate at a rate of 24.6%, compared to 13.4% among those with moderate limitations and only 6.7% among those with severe disabilities. The combined participation rate for people with disabilities is 11.3%, indicating substantially reduced access to learning opportunities.

3.4 Deinstitutionalisation: From Relocation to Community Participation

Building on the disability-related participation gap identified in the previous section, we now turn to deinstitutionalisation as a reform context and a possible response to exclusion. This section explains what deinstitutionalisation is, what it is not, and why it matters for participation in adult education and community learning. Table 2 provides a concise distinction between genuine deinstitutionalisation and practices that may only relocate or resize institutional care. The key message is that deinstitutionalisation requires choice, control, ordinary housing and stable support in the community. Without these elements, people may remain subject to institutional rules, transinstitutionalisation or reinstitutionalisation, even if they no longer live in a large institution.

Table 2. What deinstitutionalisation is and is not

Deinstitutionalisation IS	Deinstitutionalisation IS NOT
Choice and control over where and with whom a person lives, and support shaped around the person.	Living in group settings where people must adapt to organizational rules and do not control everyday life.
Closing or transforming institutions while developing diverse community-based supports in parallel.	Downsizing or renovating institutions without building accessible and sustainable community supports.
Moving people to ordinary homes and ensuring home- and community-based support.	Transinstitutionalisation (moving from one institution to another, including smaller institutional units).
Stable, sufficient support in the community regardless of changes in support needs.	Reinstitutionalisation (return to institutional care due to lack of support in the community).

Note. Adapted from the IRSSV guidebook on deinstitutionalisation [20].

Deinstitutionalisation is not simply a matter of moving people from institutions to smaller residential settings. It is a long-term reform process that seeks to reduce and close institutional living arrangements while developing diverse community-based support. It also requires continuous reflection on power relations and everyday practices, rather than a one-off organisational reform [18]. A key risk is that institutional culture and control practices can be reproduced in smaller community settings if institutional space remains available as a fallback. This may undermine genuine community participation and learning [18]. Within Slovenia's current reform agenda, this underscores the need to link transitions to community living with inclusive, low-threshold adult-learning and community-learning opportunities, consistent with the national strategy and human-rights guidance on access to mainstream services and facilities [6-8,17].

Across Europe, deinstitutionalisation has been pursued for decades. Complete closures of large institutions have been achieved in several settings (e.g., Trieste/Italy, Stockholm/Sweden, Scotland and Ireland), illustrating both feasibility and the time and coordination required to shift resources from institutional care to community-based support [19]. The Slovenian guidebook on deinstitutionalisation emphasizes that even when material conditions improve, institutional life remains inherently segregating: people have limited choice over where and with whom they live, daily routines are governed by organizational rules, and everyday contact with community life is constrained, resulting in a loss of ordinary life and dignity for people who have committed no offence [20].

Successful transitions therefore depend on meaningful participation in everyday community spaces, education, culture, leisure and civic life, supported by accessible, low-threshold opportunities and relationship-building [8,17,20]. In terms of adult education, community-learning formats such as Study Circles can provide structured social learning, trusted local networks and purposeful roles, helping to rebuild social ties after long periods of institutionalisation and reducing the risk of isolation or reinstitutionalisation [9,20].

4. Discussion

The results highlight social selectivity in adult education participation in Slovenia: participation is patterned by education, age, migration background, labour-market context and urbanisation. Descriptive disability-related findings show that adults with disabilities participate much less often in education. In line with the bounded agency perspective and research on participation in adult learning, adult education can reinforce cumulative advantage unless barriers are actively reduced and participation is supported for those with fewer resources [2-4]. This is also consistent with Bourdieu accounts of unequal distributions of cultural and social capital and their reproduction through education [1].

Beyond the strongest gradients by education and age, several predictors suggest where inclusion efforts may need additional practical scaffolding. Women show slightly higher participation than men, while people born abroad participate less, which may signal persistent barriers related to language, recognition of prior learning, institutional trust and social networks [2-4]. Workplace context also matters, participation is higher among those on fixed-term contracts and lower among those without managerial responsibilities, implying that training can be driven by employment-related incentives and organizational roles rather than by stable, self-directed learning opportunities [2-4]. Finally, lower participation in small towns and rural areas points to uneven local availability and accessibility of learning opportunities [2-4]. Although disability is not included as a predictor in the regression model due to the limited number of respondents with disabilities included in the sample, descriptive data show a pronounced participation gap, with adults with severe disabilities being the least likely to participate in education.

In the context of deinstitutionalisation, these patterns are particularly relevant. Many people transitioning to community living will not benefit from workplace-based training incentives. Some may also move to smaller local environments where formal learning opportunities are less available. This strengthens the case for low-threshold, locally embedded community-learning formats and supported entry points into existing networks.

For people with disabilities, the descriptive participation gap suggests that barriers in accessibility, adapted provision and supportive facilitation remain substantial. This matters for inclusion policy because participation in community learning can provide not only skills but also structured routines, peer contact and access to local networks, elements that are central to community belonging. [5]

In the context of deinstitutionalisation, these inequalities are especially salient. Slovenia's strategy anticipates transitions from institutional care to community living and emphasizes the need for strengthened community support and inclusive community development [6]. Human-rights guidance further stresses that reforms must ensure access to mainstream services and facilities and involve cross-sector measures and attitudinal change [7-8]. Adult education and community learning can therefore be treated as part of inclusion infrastructure rather than as an optional add-on.

Accordingly, we discuss a possible intersectoral approach to inclusion that draws on SIAE Study Circles as existing community-learning infrastructure, together with selected programmes delivered by adult education centres (Folk high schools). This approach is not presented as a proven model for deinstitutionalisation. Instead, it is framed as a feasible practice-based proposal whose outcomes should be monitored and evaluated during any future implementation. Feasible monitoring indicators include: (1) participation and retention (attendance across sessions), (2) participant-reported belonging and satisfaction, (3) growth of social contacts and community participation, (4) facilitator observations on accessibility and support needs, and (5) cross-sector coordination routines (referrals, feedback loops, local partner engagement).

Finally, the transition from institutional to community-based living is also a cultural transition. Building on contemplative scholarship that frames awareness, compassion, loving-kindness and wisdom as trainable capacities supporting prosocial action and reducing harm [10-11], we introduce a compassion-centred lens as an enabling condition for sustained cross-sector cooperation and for supporting culture change during transitions. This aligns with educational scholarship that re-centres the ethical purpose of education and views learning as relational and community-forming, especially in times of disruption [12-13], and with ethical codes that foreground dignity, non-harm and responsibility in educational practice [14-15]. Alongside these capacities, attention to time and relational facilitation can be treated as practical conditions for inclusive community learning and partnership work [16].

Limitations include the use of LFS data that does not cover people living in institutions and limited space for full model specification. Future work should therefore evaluate this possible approach through mixed-method monitoring (quantitative participation and inclusion indicators plus qualitative feedback from participants, facilitators and local partners).

5. Conclusion

Adult education participation in Slovenia is socially selective and predictably patterned by education, age and place. The participation gap by disability status indicates substantial barriers in mainstream learning opportunities. In the context of deinstitutionalisation, we therefore discuss a possible intersectoral approach to inclusion that draws on SIAE Study Circles as existing community-learning infrastructure, with outcomes to be monitored and evaluated. A compassion-centred lens (awareness, compassion, loving-kindness and wisdom) is suggested as a feasible condition for cross-sector cooperation and for supporting culture change during transitions to community living.

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Teaching German within the Framework of Intercultural Exchanges

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Abstract

This paper examines the teaching of German as a foreign language within the framework of intercultural exchanges, emphasizing its educational potential in non-formal learning contexts. Grounded in theoretical approaches to non-formal and intercultural learning, the study conceptualizes language learning as a holistic, experiential process that develops through social interaction, participation, and reflection. Intercultural learning is approached as a key educational objective, fostering intercultural competence, empathy, and critical cultural awareness among young people. Intercultural exchanges are analyzed as structured yet flexible learning environments that enable authentic communication and collaborative engagement across cultural boundaries, thereby supporting the meaningful acquisition of linguistic and social skills. Furthermore, the paper highlights the role of youth institutions and international youth work organizations in designing, implementing, and sustaining intercultural exchange programs. These institutions contribute significantly to the promotion of multilingualism, democratic values, and transnational cooperation. The study concludes that teaching German in the context of intercultural exchanges not only enhances linguistic proficiency but also supports the development of intercultural sensitivity and active citizenship, positioning language education as a central component of contemporary European youth work.

Keywords: *non-formal education, youth work, youth exchanges, intercultural competence*

1. Introduction

One of the primary objectives of foreign language teaching and learning is to foster students' awareness of multilingualism and multicultural living, while simultaneously promoting intercultural communication competence (Huneke & Steinig, 2010: 199). One effective means of cultivating intercultural communicative competence among adolescent learners is participation in intercultural exchange programmes. In Greece, such opportunities have traditionally been associated mainly with Erasmus programmes, in which English is typically used as the lingua franca for communication. In recent years, however, the establishment of the Hellenic-German Youth Foundation has created new opportunities for intercultural exchanges between Greece and Germany and/or France. Through these initiatives, participants are able to come into direct contact with native speakers and use the foreign languages they have studied for several years in authentic communicative contexts, an element considered fundamental within the framework of contemporary foreign language pedagogy (Savignon, 2017). Although similar youth foundations and exchange programmes between Germany and other countries have existed for several decades, such initiatives have only recently begun operating in Greece, specifically since 2021. Consequently, the educational opportunities provided through these programmes are gradually becoming more widely recognized within both formal and non-formal education settings.

The present study aims to highlight the educational value of intercultural exchanges and to investigate their impact and effectiveness in relation to different dimensions of foreign language teaching and learning, with particular emphasis on German language education. Special attention is given to the cognitive, social, and intercultural benefits that may emerge through participation in such programmes. This focus is particularly relevant, as intercultural communicative competence (Baros, Stergiou & Chatzidimou, 2014) is increasingly considered one of the key competencies required of individuals in contemporary multilingual and multicultural societies.

2. Theoretical Background

2.1 Non-formal Education

Non-formal learning is generally defined as learning that takes place outside the framework of compulsory curriculum-based instruction and formal teaching hours. It may occur either within the school environment, for example through educational groups and extracurricular activities, or outside formal educational settings, such as in foreign language centres and youth programmes. Non-formal learning activities are highly diverse, as the objectives of non-formal education encompass a broad range of educational, social, and personal dimensions. In general, non-formal learning refers to planned educational activities that may not always be explicitly identified as "learning" in terms of learning objectives, duration, or instructional support, yet remain intentional from the learner's perspective (Cedefop, 2008: 133).

One of the distinctive characteristics of non-formal learning is its emphasis on the targeted development of personal and social competences, including initiative-taking, collaboration, communication, and active participation. In this sense, non-formal education promotes a more authentic and learner-centred approach to the learning process, encouraging learners to assume greater responsibility for their own educational development. More specifically, non-formal learning differs from formal education due to its less teacher-centred structure, while at the same time differing from informal learning because it is usually organised, facilitated by trained staff, and based on specific educational objectives and methodologies. Consequently, it may be described as an experiential form of learning and skills development grounded in voluntary participation and focused primarily on the learner's active engagement. Such approaches are widely implemented in mobility and intercultural exchange programmes, where non-formal learning constitutes a central methodological framework. In these contexts, non-formal educational practices are extensively employed by youth workers and educators, contributing significantly to young people's personal, educational, and social development.

2.2 Intercultural Learning

One of the central aims of foreign language learning is the development of learners' ability to communicate effectively, both orally and in written form, with native speakers of the target language. Nevertheless, when exposure to the target language remains limited to the classroom environment, achieving this objective often becomes challenging, since important aspects of authentic communication -such as stylistic variation, intonation patterns, spontaneity, and familiarity with cultural practices- may remain insufficiently developed. Within the framework of communicative language teaching, emphasis is placed on moving beyond traditional teaching methods and exclusive dependence on the textbook, towards a more communication-oriented and learner-centred approach (Savignon, 2017: 138). In this context, intercultural exchange programmes can function as an important complement to classroom instruction, as they provide learners with opportunities to engage in authentic communicative situations and interact directly with native speakers of the target language (Edelenbos & Kubanek, 2004: 20).

Research findings indicate that participation in intercultural exchanges may contribute positively to both receptive and productive language skills. More specifically, participants often appear to improve their listening comprehension while simultaneously developing greater confidence and fluency in oral communication by the end of the exchange experience (Edelenbos & Kubanek, 2004: 20). Such experiences reflect one of the fundamental principles of contemporary language teaching, namely the active involvement of learners in meaningful communicative situations that resemble real-life language use beyond the classroom environment (Chatzidimou & Stamovlasis, 2014: 41). Furthermore, communication within intercultural exchanges is not limited to linguistic development alone. Interaction with peers in authentic social contexts often acquires emotional significance, particularly when meaningful interpersonal relationships are formed. As Edelenbos and Kubanek (2004: 23) argue, communication experiences connected to personal interaction and emotional engagement tend to leave a more lasting impact on participants than isolated or impersonal communicative encounters. Consequently, intercultural exchanges may substantially influence learners' autonomy, self-confidence, and understanding of the culture of the "other" (Edelenbos & Kubanek, 2004: 20).

At the same time, intercultural contact encourages learners to reflect critically on their own cultural assumptions while becoming aware of alternative ways of thinking and behaving. According to Heringer (2004), encounters with individuals from different cultural backgrounds may create moments of tension or misunderstanding, precisely because participants are confronted with perspectives and behavioural norms different from their own. Such challenges become even more evident in international youth

exchanges, where participants differ not only in terms of cultural background, but also in language proficiency, communicative competence, expectations, and previous intercultural experiences. As a result, communication difficulties are often unavoidable in intercultural settings characterised by such diversity. In some cases, misunderstandings may contribute to the formation or reinforcement of stereotypes, prejudices, or insecurities among participants. However, these situations also create opportunities for reflection, negotiation of meaning, and intercultural learning.
Through intercultural learning processes (Lane, 2012), learners gradually develop intercultural communicative competence, which includes both verbal and non-verbal dimensions of communication. Participants become more aware that communicative behaviour differs across cultural contexts and, consequently, acquire strategies that facilitate more effective interaction. In addition, they develop the ability to interpret misunderstandings, negotiate meaning, and demonstrate empathy towards cultural difference (Biechele & Padros, 2003). This perspective is further supported by Byram's (2008) model of Intercultural Communicative Competence in foreign language education, according to which learners should develop, among other competences, the ability to interpret cultural phenomena within intercultural contexts and to independently acquire new knowledge regarding other cultures.

2.3 Intercultural Youth Exchanges

International youth exchanges constitute an important component of both formal and non-formal educational opportunities for young people in many countries. Their long-term impact has been examined extensively, including within the framework of the research project *Long-term Effects of Participation in International Youth Meetings on the Personal Development of Participants*, conducted by a research team at the University of Regensburg. One of the central conclusions of the study is that even relatively short intercultural experiences may have a lasting influence on participants' personal development. Beyond the improvement of foreign language skills, participation in intercultural exchanges appears to contribute positively to self-confidence, teamwork abilities, openness towards new perspectives, and, consequently, to young people's future professional opportunities.
At the same time, the demands placed upon young people in an increasingly globalised and multicultural world are becoming progressively more complex. The process of shaping one's identity and developing a stable sense of self within rapidly changing social environments often presents significant challenges. In this context, intercultural exchanges may play an important role, as they foster the development of intercultural competence and encourage participants to engage constructively with cultural diversity. Through participation in such programmes, young people are provided with opportunities to strengthen communication skills, develop empathy and adaptability, and acquire experiences that may prove valuable both in their everyday social interactions and in their future professional lives. The ability to coexist and cooperate effectively within multicultural environments is increasingly regarded as an essential competence in contemporary societies.
For these reasons, intercultural exchanges should be considered an integral element of youth work and educational practice. Their educational and social potential highlights the importance of further supporting, expanding, and systematically integrating such programmes into both formal and non-formal educational contexts.

2.4 IJAB – Specialist Office for International Youth Work of the Federal Republic of Germany e.V.

IJAB serves as a central institution for the promotion and coordination of international youth work and youth policy cooperation in Germany, both within Europe and at a global level. Its primary objective is to foster mutual understanding through the promotion of international youth exchanges and intercultural encounters, while simultaneously supporting international education, youth participation, and the prevention of xenophobia, racism, and violence. In cooperation with international partners, IJAB implements projects related to youth policy and facilitates the exchange of knowledge and expertise in the field of child and youth welfare. Furthermore, it promotes networking among institutions and organisations operating in youth work both within Germany and internationally.
In addition, IJAB provides information, counselling, and professional support to youth welfare organisations, policy makers, and public administrations. Its activities include the organisation of training opportunities, professional exchange programmes, educational resources, and specialist publications related to international youth work. At the same time, the organisation offers guidance to young people regarding opportunities for international mobility and available funding schemes. As the specialised agency for international youth work in the Federal Republic of Germany, IJAB has been operating since

1967 under the auspices of the Federal Ministry for Family Affairs, Senior Citizens, Women and Youth, in collaboration with its member organisations and other youth work institutions (https://www.dfjw.org/das-dfjw-entdecken.html).

2.5 Hellenic-German Youth Foundation

The Hellenic-German Youth Foundation (HGYF) was established following the bilateral agreement signed on 4 July 2019 between the Federal Republic of Germany and the Hellenic Republic, officially commencing its operations in Leipzig and Thessaloniki in April 2021. The Foundation functions as an international organisation dedicated to supporting and financing Greek-German youth exchanges, as well as professional exchanges among youth workers. Its primary objective is to strengthen mutual understanding and intercultural dialogue between young people from Greece and Germany by creating opportunities for meaningful intercultural encounters and cooperation.
Within this framework, the Hellenic-German Youth Foundation promotes a wide range of educational and intercultural activities, including youth exchange programmes, professional exchanges, internships, job-shadowing initiatives, and small-scale collaborative projects. Such initiatives enable young people from both countries to meet, interact, exchange perspectives, and cooperate on topics of common interest, thereby fostering intercultural learning, active participation, and international collaboration (https://dgjw-egin.org/wir-ueber-uns/).

3. Practical Background

3.1 The Aim of the Research

The aim of this study is to highlight the importance of intercultural exchanges and their potential benefits across multiple dimensions of participants' development, including social and cognitive aspects. More specifically, the study first focuses on the development of oral comprehension skills. By assessing participants' listening comprehension before and after the exchange programme, the study seeks to examine the extent to which their ability to understand native speakers of German is affected by participation in the exchange.
A further objective is to investigate the development of oral production skills. By comparing participants' oral performance prior to and following the exchange, the study aims to determine the extent to which their communicative effectiveness and fluency in interactions with native speakers have improved. Based on prior experience, it is hypothesised that more pronounced improvements may be observed among participants at A2-B1 proficiency level, as they are already equipped with a sufficient range of linguistic structures and vocabulary to manage a variety of communicative situations.
Finally, the study also explores participants' attitudes towards different cultures, as well as their broader perspectives on multilingualism and the equal status of languages.

3.2 Research Questions

The present study seeks to explore the impact of intercultural exchange programmes on foreign language learning and intercultural development, with particular emphasis on German as a foreign language. More specifically, the research focuses on participants' linguistic confidence, communicative competence, and attitudes towards multilingualism and cultural diversity. In this context, the research questions addressed in this study are the following:

1. To what extent do exchange participants feel more confident in understanding spoken German by native speakers following their participation in the exchange programme?
2. To what extent do participants feel more confident and effective in oral communication with native German speakers after participating in the exchange programme?
3. What are participants' attitudes towards the target language (German) and the corresponding culture?
4. What are participants' attitudes towards multilingualism?

3.3 Methodology and Research Tools

Regarding the methodology employed in the research component of the study, a mixed-methods approach was adopted in order to explore participants' linguistic development, intercultural

communication, and attitudes towards multilingualism within the context of a youth exchange programme.
Initially, a pre-exchange questionnaire was administered to the eight Greek participants in order to examine their perceptions regarding German language comprehension and use, as well as issues related to intercultural contact and multilingualism. The questionnaire consisted of 13 closed-ended questions.Throughout the duration of the exchange programme, a daily observation protocol was completed for each participant individually. The protocol included approximately 10 items focusing primarily on participants' interaction with peers, communication patterns, and engagement in intercultural activities. At the end of the exchange, a post-exchange questionnaire was distributed to all participants. This instrument aimed to investigate their overall experience, perceived language development, intercultural communication skills, and evolving attitudes and perspectives. The questionnaire consisted of 41 closed-ended questions and two open-ended questions, allowing participants to further elaborate on their experiences.
In addition, online semi-structured interviews were conducted a few days after the completion of the exchange programme. The participants responded to approximately 12 open-ended questions focusing on their experience of coexistence and collaboration, language development, intercultural interaction, and the attitudes and perceptions developed through participation in the exchange. Furthermore, one or two parents of each participant were also interviewed and answered 11 questions related to the cognitive, emotional, and personal changes they observed in their children following participation in the programme, including aspects such as autonomy, self-confidence, initiative-taking, and social development.

4. Discussion and Preliminary Conclusions

At the current stage of the research, the analysis and triangulation of the collected data are still in progress. Nevertheless, preliminary findings indicate an overall positive evaluation of participation in the exchange programme. More specifically, participants appeared to develop more positive attitudes towards other cultures, while also demonstrating signs of personal growth, increased autonomy, enhanced self-confidence, and a greater willingness to take initiative in intercultural settings. Preliminary findings further suggest that participation in intercultural exchanges enhanced students' motivation, strengthened their intercultural awareness, and increased their confidence in authentic communication in the German language.

5. Conclusions

Intercultural exchange programmes constitute an important educational context that combines foreign language learning with experiential and intercultural education. Through authentic communication and direct interaction with native speakers and individuals from different cultural backgrounds, learners are provided with opportunities to develop not only their linguistic competences, but also broader social, personal, and intercultural skills. In this respect, intercultural exchanges appear to support the principles of contemporary communicative language teaching by connecting language learning with meaningful real-life communication and intercultural engagement.
Furthermore, the present study highlights the importance of integrating non-formal learning practices into foreign language education, particularly in relation to the teaching and learning of German as a foreign language. The findings discussed in this paper suggest that participation in intercultural exchanges may positively influence learners' motivation, communicative confidence, intercultural awareness, and openness towards multilingualism and cultural diversity. Consequently, intercultural exchange programmes should be regarded as valuable educational initiatives capable of contributing both to language development and to the formation of active and interculturally aware citizens.

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The Perception of Social Science Students on the Importance and Application of Intercultural Competencies in Education and Professional Life

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Abstract

In today's world, the term interculturality is increasingly used across various segments of life, from education to the professional environment. Modern society continuously witnesses interactions among people from different cultures, nationalities, faiths, and races, resulting in a growing need for strengthening intercultural competencies. Intercultural competencies are crucial in the educational system, where their application can significantly contribute to the development of multiperspectivity, empathy, and cognitive flexibility among pupils and students. Given that most students of social sciences will spend their professional careers in educational institutions, this paper aims to examine how well students of social sciences faculties at the Josip.Juraj Strossmayer University of Osijek are acquainted with the concept of intercultural competencies, how they value them, and in which ways they would apply them in their future professions.

The research was conducted using a survey method on a sample of 89 students. The results indicate that the majority of students recognize intercultural competencies as highly important for their future professional work, but they assess their own preparedness for their application as moderate. It was observed that a significant number of respondents have not had the opportunity to apply intercultural competencies practically during their studies. At the same time, most believe the representation of such content in curricula is insufficient. The findings confirm theoretical theses regarding the necessity of systematically integrating intercultural content into educational programs and point to the need for a strategic approach involving formal education, experiential learning, and international cooperation. The findings show that 68.5% of students believe that intercultural competencies should be more strongly integrated into higher education curricula.

Keywords: *intercultural competencies, quantitative analysis, curricula, educational system, social science students, Josip.Juraj Strossmayer University of Osijek*

1. Introduction

The contemporary globalized society assumes that intercultural competencies are becoming a key prerequisite for successful professional and personal engagement. We are witnessing increased interconnectedness of cultures and human mobility, where value pluralism changes the context of work in the educational system and other domains of social sciences. Such an environment requires from future professionals not only expertise and methodological skills but also the ability to communicate effectively and appropriately with individuals from various cultural, linguistic, and social backgrounds. Intercultural competence is defined as a set of knowledge, skills, attitudes, and values that enable constructive interaction in intercultural encounters, and it is recognized as a fundamental transversal competence in higher education [4,5,6]. The educational system plays a significant role in raising awareness of and developing intercultural competencies, as education forms the foundation for adopting values of understanding, respect, and acceptance of diversity among younger generations. New societal needs present students, especially those in the social sciences, with the requirement to acquire competencies that will enable successful performance in their future professional lives, primarily in educational institutions but also in other socially relevant settings. It is assumed that social science students will often work in multicultural environments in the future. Their ability to understand, appreciate, and respond constructively to cultural differences is essential for directly influencing the quality of professional relationships, the effectiveness of teamwork, and overall user satisfaction. Despite the widespread awareness of these concepts, research in Croatia and the region indicates inadequate systemic development of intercultural competencies within

study programs and the need to enhance them through targeted educational experiences, international mobility, and interdisciplinary projects [7,9].
Given this context, this paper aims to examine how familiar social science students at the Josip. Juraj Strossmayer University of Osijek are with the concept of intercultural competencies, how they assess and value them, and in which ways they recognize their importance and possible application in personal and professional life. Particular emphasis is placed on students' perceptions of the need to strengthen intercultural content in higher education curricula. The results of the conducted research should contribute to a better understanding of student needs and the development of educational outcomes that will enable the systematic and strategic development of intercultural competencies in higher education. In addition, this study contributes to the existing literature by providing empirical insight into students' perceptions in the Croatian higher education context.

2. Review of Relevant Literature

When it comes to the conceptual definition of intercultural competencies, it is essential to note that the term "intercultural competence" encompasses knowledge, skills, attitudes, and values that enable individuals to act effectively and appropriately in intercultural contact situations. The idea of interculturalism in education emerged as a result of the need to shape multicultural societies according to the principles of cultural pluralism, which presupposes mutual understanding, tolerance, and dialogue [2]. The literature contains several models of intercultural competence. Deardorff's process model integrates intrinsic dispositions (respect, openness, and curiosity), knowledge and skills (interpretation and relativization), and internalized outcomes (adaptation and ethical responsibility), which collectively lead to effective and appropriate communication [6]. This model has become a global reference framework in higher education. In the linguistic-educational tradition, Byram's model of intercultural communicative competence stands out, consisting of five components: attitudes, knowledge of societies and cultures, skills of interpreting and relating, skills of discovery and interaction, and critical cultural awareness [5]. Bennett's developmental model of intercultural sensitivity describes the transition from ethnocentric (denial/defense/minimization) to ethno-relative orientations (acceptance/adaptation/integration) and is often used as a theoretical basis for monitoring shifts in education [4].
It is also important to mention the European normative and curricular framework. In 2018, the Council of Europe developed the Reference Framework of Competences for Democratic Culture (RFCDC), encompassing twenty competencies grouped into four domains: values, attitudes, skills, and knowledge and critical understanding. These competencies are essential because intercultural competencies are a central element, and guidelines for higher education emphasize the necessity of their integration at all levels and forms of learning. The application of these competencies enables understanding and assessment of intercultural competencies. Comprehension and implementation of intercultural competencies are being introduced in many sectors of society, notably in education, and especially in higher education. Curriculum internationalization, student mobility, and foreign language learning are highlighted as key factors in the development of intercultural competencies [11]. Analysis of relevant literature shows that participation in international programs alone is not sufficient for significant competence development; structured learning, mentoring, and reflective activities are needed [13]. In the regional (specifically Croatian) context, available research highlights the limited integration of intercultural content in social science curricula and the necessity of its systematic inclusion in both formal and non-formal educational forms. It is also observed that students involved in international exchanges or interdisciplinary projects exhibit higher levels of intercultural sensitivity and cultural intelligence [7,9]. Further research indicates that social science students recognize the significance of intercultural competencies, primarily in the context of future professional application—especially openness to diversity, communication skills, conflict resolution ability, and the capacity to view problems from other perspectives. Analyses have shown that the level of development and perception of these competencies depend on age, gender, study program, country of study, as well as the availability of intercultural content in educational programs [3,12]. Since the importance of interculturality and intercultural competencies remains a crucial aspect of everyday life, literature frequently emphasizes these themes in the context of future professionals entering the labor market. For future experts in social sciences, intercultural competencies offer numerous professional benefits, enabling better management of diverse teams, more effective conflict resolution, adjustment of communication strategies, and increased user satisfaction [1]. According to the European Commission, the labor market has recognized intercultural competence as an essential hiring criterion, particularly in the public sector,

education, international organizations, and NGOs [8]. The literature overview points out that intercultural competencies constitute a complex set of knowledge, skills, attitudes, and values that can be systematically developed and assessed. Theoretical models, such as those mentioned above [4,5,6], provide a conceptual framework, while RFCDC offers a normative and operational framework for their implementation in educational practice. In higher education, the integration of intercultural competencies in curricula and institutional strategies is necessary.

3. Methodology

3.1 Research Design

This study employed a quantitative research design to examine social science students' perceptions of intercultural competencies, their perceived importance, and their potential application in professional contexts. A survey method was used as it enables the collection of standardized data from a larger number of participants and allows for statistical analysis of attitudes, perceptions, and self-assessments. The research focuses on identifying patterns related to familiarity with the concept of intercultural competencies, perceived importance, level of preparedness, and the perceived need for their integration into higher education curricula.

3.2 Sample

The study was conducted on a sample of N = 89 students enrolled at the Josip Juraj Strossmayer University of Osijek. Participants were undergraduate and graduate students from four faculties within the field of social sciences: the Faculty of Humanities and Social Sciences (59.6%), the Faculty of Education (23.6%), the Faculty of Economics (11.2%), and the Faculty of Law (5.6%).
Regarding gender distribution, the sample consisted predominantly of female respondents (83.1%, n = 74), followed by male respondents (13.5%, n = 12), while 2.2% (n = 2) identified as other and 1.1% (n = 1) chose not to disclose their gender.
In terms of age, the majority of respondents belonged to the 20–22 age group (51.7%), followed by the 23–25 age group (31.5%). The sample was based on convenience sampling, which limits the generalizability of the findings but is appropriate for exploratory research of this type.

3.3 Instrument

Data were collected using a structured questionnaire designed specifically for the purposes of this study. The instrument consisted of both closed-ended and open-ended questions and was divided into several thematic sections:

- socio-demographic characteristics
- familiarity with the concept of intercultural competencies
- sources of knowledge about intercultural competencies
- perceived importance of intercultural competencies
- self-assessment of preparedness for intercultural interaction
- prior experience in applying intercultural competencies
- evaluation of the representation of intercultural content in curricula
- suggestions for improving intercultural competence development

A five-point Likert scale was used to measure attitudes and perceptions, where 1 indicated the lowest level (e.g., "not important at all" or "very poor") and 5 indicated the highest level (e.g., "very important" or "excellent").
The inclusion of open-ended questions enabled the collection of qualitative insights, providing additional depth to the interpretation of quantitative findings.

3.4 Procedure

The data collection was conducted online using Google Forms in the period from May to July 2025. Participants were recruited through multiple channels, including student mailing lists, social media platforms, and direct contact during lectures.
The online format enabled efficient data collection and ensured accessibility for participants across different faculties.

3.5 Ethical Considerations

Participation in the study was voluntary and anonymous. All participants were informed about the purpose of the research prior to completing the questionnaire. Informed consent was obtained, and respondents were assured that their data would be used exclusively for academic purposes.
No personally identifiable information was collected, and the study was conducted in accordance with standard ethical principles for social science research.

3.6 Research Hypotheses

Based on the research objectives and theoretical framework, the following hypotheses were formulated:
H1: Social science students are familiar with the concept of intercultural competencies.
H2: Students perceive intercultural competencies as highly important for their future professional work.
H3: Students assess their level of preparedness for applying intercultural competencies as moderate.
H4: Intercultural competencies are insufficiently represented in higher education curricula.
H5: Students express a need for increased integration of intercultural competencies into study programs.
These hypotheses guided the analysis and interpretation of the research results.

4. Research Results and Interpretation

The results are presented in accordance with the defined research hypotheses (H1-H5). This section presents the results and interpretation of conducted research on the perception of social science students at the Josip Juraj Strossmayer University of Osijek regarding the importance and application of intercultural competencies. The results follow the established research questions: level of awareness, perception of importance, intended application, experiential application, and perception of representation in the curriculum. The analysis also includes qualitative insights from open-ended questions.

4.1 Sample Characteristics

A total of 89 students from four faculties participated: the Faculty of Humanities and Social Sciences in Osijek (59.6%), the Faculty of Education (23.6%), the Faculty of Economics (11.2%), and the Faculty of Law (5.6%). Most respondents (30.3%) were in the 2nd year of undergraduate studies, while the smallest number were in the 2nd year of graduate studies (6.7%). As for gender (Figure 1. Distribution of Responses by Gender), the sample consisted of 74 women (83.1%), 12 men (13.5%), two students who identified as “other” (2.2%), and one student who did not wish to state their gender (1.1%).

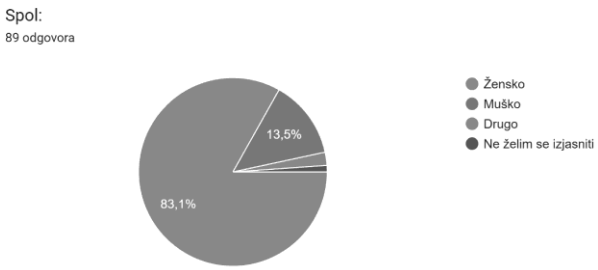


Fig.1. Distribution of Responses by Gender

4.2 Familiarity with Intercultural Competencies (H1)

Analysis of age groups revealed that the 20–22 age group dominates (51.7%), followed by the 23–25 group (31.5%). Regarding familiarity and understanding of the term “intercultural competencies,” the majority (39.3%) indicated they were familiar with the term, while 30.3% were not familiar and an equal percentage were unsure. The self-assessment of understanding “intercultural communication” (Likert scale: 1–5) averaged 3.4, indicating a moderate to good experience, although with room for further education. Detailed information is shown in Figure 2. Display of Self–Assessment Responses on Understanding the Concept of Intercultural Competence. These findings provide partial support for H1. Although a proportion of students report familiarity with the concept, a considerable number of

respondents indicate that they are either not familiar or unsure, suggesting that knowledge of intercultural competencies is not systematically developed.

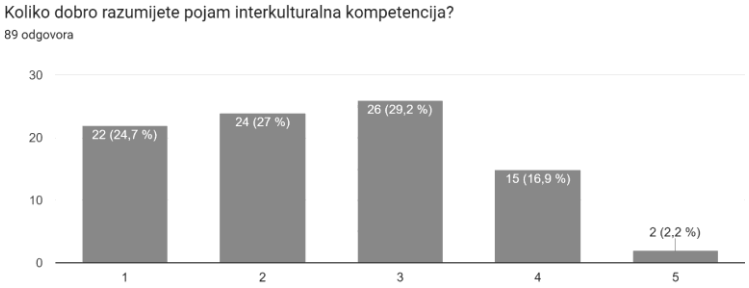


Fig. 2. Self-assessment of understanding intercultural competencies

Most respondents (42.7%) stated they had not encountered the term “intercultural competencies,” while a slightly smaller proportion (36%) heard it in lectures, and 25.8% encountered it in the media.

4.3 Perceived Importance of Intercultural Competencies (H2)

Self-assessment of the importance of intercultural competencies in today’s society, according to respondents, showed that 36% consider them very important (Likert scale score 5), 29.2% gave a score of 4, and 31.5% gave a score of 3. Similar results are seen for the question on the perceived importance of intercultural competencies in future careers, with most providing a score of 4 (33.7%), followed by score 5 (32.6%) and score 3 (30.3%). Students believe that there is a need to strengthen intercultural competencies in modern society, with 68.5% agreeing with this statement and 30.3% unsure. The characteristics most frequently highlighted by students as crucial for developing intercultural competencies are communication skills (83.1%), tolerance (76.4%), empathy (67.4%), multiperspectivity (65.2%), and cognitive flexibility (46.1%). Among all participants, 39.3% would very likely apply intercultural competencies in their future professions, 33.7% would likely do so, while 23.6% are sure they would use them. For the open-ended question regarding specific situations where they would apply intercultural competencies, most students mentioned collaboration with colleagues from other countries (e.g., Erasmus, future jobs, etc.). The results clearly support H2, as most respondents perceive intercultural competencies as important or very important in both societal and professional contexts.

4.4 Self–Assessed Preparedness (H3)

Self-assessment of preparedness for working in multicultural environments showed that most rated themselves as “good” (3)—50.6%, followed by “very good” (4)—25.8%, and “adequate” (2)—14.6%. These findings support H3, indicating that students generally perceive their level of preparedness as moderate rather than high, which points to a gap between awareness and practical competence.

4.5 Experience and Application of Intercultural Competencies

Most respondents have not yet had the opportunity to apply intercultural competencies during their studies or practice. Those who have applied intercultural competencies cited teaching students from different cultures, participating in student exchanges (Erasmus), involvement in the European Law Students’ Association (ELSA), conferences, and lectures by foreign experts.

4.6 Representation in the Curriculum (H4)

Over half of the respondents (52.8%) are unsure if the concept of intercultural competencies is sufficiently represented in their curriculum. Only 13.5% believe it is adequately represented, while 33.7% disagree, as reflected in the relevant Figure 3. The results support H4, as a relatively small proportion of students believe that intercultural competencies are adequately represented in the curriculum, while a significant number express uncertainty or disagreement.

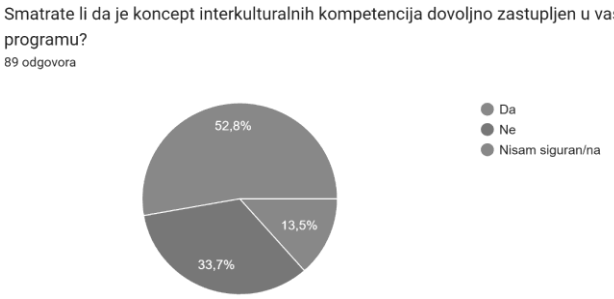


Fig. 3. Representation of Intercultural Competencies in Study Programs

4.7 Need for Improvement (H5)

Most respondents (68.5%) believe that the representation of content related to intercultural competencies should be increased, while 24.7% are unsure. These findings strongly support H5, confirming that students recognize the need for increased integration of intercultural competencies into higher education programs. Workshops or seminars (59.6%), international student exchanges (57.3%), guest lectures by experts from abroad (51.7%), and courses focused on interculturality (43.8%) are considered the most suitable forms for developing intercultural competencies. Suggestions for further improving the development of intercultural competencies within the studies mainly refer to ERASMUS programs, various educational activities and workshops with international experts, more courses dedicated to interculturality, or inclusion of intercultural topics in existing course content.



Fig. 4. Self–Assessment – Do you believe your studies adequately prepare you for work in an Intercultural Environment?

4.8 Perception of Study Preparation

When it comes to self-assessment and respondents' opinions about whether their studies adequately prepare them for work in an intercultural environment, 56.2% believe they are partially prepared, and 24.7% feel their studies do not prepare them sufficiently (see Figure 4).

5. Discussion

The discussion of the findings is structured in relation to the defined research hypotheses (H1–H5), allowing for a clearer interpretation of the results within the established theoretical framework.

The findings related to students' familiarity with intercultural competencies provide only partial support for H1. Although a proportion of respondents reported being familiar with the concept, a considerable number indicated limited or no familiarity, as well as uncertainty regarding its meaning. This suggests that knowledge of intercultural competencies is not systematically developed within higher education. Such findings are consistent with previous research in the Croatian context, which points to the insufficient integration of intercultural content into study programs [2,12]. The lack of consistent exposure to key concepts may result in fragmented understanding, where students recognize elements of interculturality without a clear theoretical framework.

In contrast, the results strongly support H2, as the majority of students perceive intercultural competencies as highly important for both societal functioning and their future professional roles. These

findings align with established theoretical models of intercultural competence, particularly those proposed by Deardorff (2006), Byram (1997), and Bennett (2017), which emphasize the central role of intercultural skills in effective communication and professional success in multicultural environments. The high valuation of intercultural competencies suggests that students are aware of contemporary societal demands and the importance of such competencies in the global labor market.

At the same time, the findings confirm H3, indicating that students assess their level of preparedness for applying intercultural competencies as moderate rather than high. This points to a discrepancy between the recognized importance of these competencies and students' perceived ability to apply them in practice. Such a gap suggests that current educational approaches may not provide sufficient opportunities for experiential learning or practical engagement. Similar conclusions have been drawn by Leask (2015) and Sobkowiak (2019), who argue that exposure to intercultural environments alone is not sufficient; rather, structured learning, guided reflection, and practical application are essential for meaningful competence development.

The results also support H4, highlighting that intercultural competencies are not perceived as adequately represented in university curricula. A relatively small proportion of students believe that such content is sufficiently included, while many express uncertainty or dissatisfaction. This finding reflects broader structural limitations within higher education systems, where intercultural competencies are often addressed indirectly or inconsistently. The absence of clearly defined learning outcomes and systematic integration into curricula may hinder the development of these competencies.

Finally, the findings strongly support H5, as the majority of students express a clear need for increased integration of intercultural competencies into higher education programs. Students particularly emphasize the importance of experiential learning formats, such as workshops, international exchanges, and guest lectures by foreign experts. These preferences are consistent with experiential learning theory [10] and models of intercultural competence development, which highlight the importance of active participation, reflection, and real-life interaction. The emphasis on practical learning indicates that students not only recognize the importance of intercultural competencies but also understand the conditions necessary for their development.

Overall, the results indicate that while students demonstrate a high level of awareness regarding the importance of intercultural competencies, there remains a significant gap in their systematic development within higher education. The findings point to the need for a more structured and strategic approach to integrating intercultural competencies into curricula, including clearly defined learning outcomes, practical training opportunities, and institutional support for internationalization. Such an approach would enable students to move beyond theoretical awareness toward the development of applicable skills necessary for functioning in increasingly diverse professional environments.

6. Conclusion

This study confirms that social science students at the Josip Juraj Strossmayer University of Osijek recognize the importance of intercultural competencies, thereby supporting hypothesis H2. However, the findings also reveal only moderate levels of self-assessed preparedness (H3), indicating a gap between awareness and practical competence development.

The results further show that a significant proportion of students have not encountered the concept within formal education, supporting hypothesis H4 regarding insufficient curricular representation. At the same time, students clearly express the need for increased integration of intercultural content (H5), particularly through experiential forms of learning such as workshops and international exchanges.

Although students demonstrate partial familiarity with the concept (H1), the findings suggest that this knowledge is often fragmented and lacks a structured theoretical foundation.

Overall, the study highlights the need for a systematic and strategic approach to integrating intercultural competencies into higher education curricula. This includes the development of structured learning opportunities, practical training, and international collaboration.

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Leadership Practices for Inclusion in the Context of External School Evaluation: Findings from a Portuguese Case Study

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Abstract

In Portugal, the external evaluation of schools, conducted by the Inspectorate-General of Education and Science, constitutes a significant instrument for regulation, accountability and organisational improvement within an education system guided by principles of equity and inclusion. In this context, it is important to understand how school leaders make use of this evaluative mechanism to guide processes of institutional reflection, regulate educational action and sustain practices that are better attuned to student diversity. A qualitative case study was conducted in a cluster of schools in mainland Portugal, based on the analysis of the external evaluation report, key institutional documents and interviews with 12 teachers holding leadership roles. Using MAXQDA software, the data were organised and interpreted around four dimensions – strategic, organisational, pedagogical and community – in order to explore the interplay between school leadership, institutional evaluation and inclusion-oriented practices. Ethical procedures applicable to educational research were followed, including informed consent, the anonymisation of participants and the protection of the data collected. The results show that school leaders mobilise external evaluation to promote more inclusive responses through the strategic use of evaluative data, collaborative decision-making, the organisation of support structures, the monitoring of teaching practices and the alignment between school improvement processes and education policies. However, the data also reveal that this appropriation is not linear, being shaped by challenges related to the articulation between self-evaluation and planning, the consolidation of formative assessment and collaborative supervision, limited resources and family engagement. The analysis further shows that the increasing number of students of foreign nationality, together with the linguistic and cultural plurality of the school population, emerges as a particularly significant challenge, requiring contextualised and appropriately tailored responses. It is concluded that external evaluation can foster critical reflection, organisational learning and educational transformation when appropriated by school leaders as an instrument for continuous improvement, shared responsibility and the consolidation of sustainable inclusive practices. Nevertheless, its effects depend on organisational conditions, available resources and the capacity to translate the evidence base produced by evaluation into effective practices.

Keywords: *External School Evaluation; School Leadership; Inclusive Education; Linguistic and Cultural Diversity; Portugal.*

1. Introduction

Inclusive education has become firmly established on international and, in particular, European policy agendas as a structuring principle of quality, equity and educational justice [1,2]. In a context marked by increasing social, cultural and linguistic diversity among school populations, education systems are called upon to ensure not only access to schooling, but also the effective participation, learning, well-being and success of all students [2,3]. Accordingly, inclusion is understood here not as a response to a specific group of students, but as a multidimensional commitment to identifying and removing barriers that hinder students' participation, learning, well-being and success, including those related to social inequality, disability, language, culture and migration trajectories [1,3].

The OECD emphasises that phenomena such as demographic change, migratory movements, refugee crises and rising inequalities have contributed to the growing diversity of school populations, requiring more equitable and inclusive educational responses [3]. This concern is also reflected at the European level, where the integration of migrant and refugee children and young people into education and training systems has been regarded as a policy priority [4,5,6].

In Portugal, this issue is particularly relevant given the marked increase in the number of students of foreign nationality in compulsory education, which covers children and young people aged between 6 and 18, under Law No. 85/2009 [7]. In 2023/2024, 174,126 children and young people of foreign

nationality were enrolled in compulsory education in Portugal, 31,366 more than in the previous year, representing 13.6% of students in basic and secondary education, excluding adult learners [8]. Of these, 84.3% attended state schools, indicating that although cultural and linguistic diversity cuts across the education system as a whole, it is particularly relevant in state schooling [8].

Beyond this quantitative increase, the current diversity of Portuguese schools is also reflected in the multiplicity of national and linguistic backgrounds. Recent data from the National Education Council indicate that, in 2023/2024, school clusters and non-clustered schools had, on average, around 18 nationalities, with some contexts having more than 40 nationalities represented [9]. These changes do not constitute a transient circumstance, but a structural transformation of the school population, unfolding at a pace that often outstrips schools' capacity to adapt their organisation, curriculum management and pedagogical work. Understanding how schools respond to this transformation is therefore not merely relevant, but pressing.

Within the national policy and regulatory framework, Decree-Law No. 54/2018 establishes the principles and rules that guarantee inclusion, understood as a process aimed at responding to the diversity of the needs and potential of each and every student, by increasing participation in learning processes and in the life of the educational community [10]. In turn, Decree-Law No. 55/2018 establishes the curriculum for basic and secondary education and the guiding principles for its design, implementation and assessment, seeking to ensure that all students develop the competences set out in the Students' Profile by the End of Compulsory Schooling [11]. Taken together, these legal instruments support a conception of schooling oriented towards inclusion, curriculum flexibility, pedagogical differentiation and the improvement of learning. However, the existence of regulatory guidelines favourable to inclusion does not, in itself, guarantee their enactment in organisational and pedagogical practices.

Linguistic and cultural diversity makes this framework even more complex, particularly when it involves migrant or refugee students, or students whose schooling trajectories have taken place in languages other than Portuguese. Their inclusion requires welcoming practices, sociolinguistic diagnosis, language support, cultural mediation and curriculum management that is sensitive to context. In this domain, the provision of Portuguese as a Non-Native Language (PLNM) constitutes a relevant response to support students whose mother tongue or language of schooling is not Portuguese. The guidelines recently made available by the Directorate-General for Education aim to support the linguistic and curricular inclusion of migrant students with very limited knowledge of Portuguese [12]. In this context, school leaders play a decisive role in the enactment of inclusive policies, insofar as they are responsible for interpreting and translating regulatory guidelines into contextualised organisational, curricular and pedagogical practices [13]. Responding to diversity, therefore, requires strategic vision, resource management, collaborative work, engagement with families, communities, municipalities, and other local partners, as well as the monitoring and evaluation of the measures implemented.

Recent studies on the external evaluation of schools have highlighted its relationship with processes of autonomy, curriculum management and school improvement [14]. However, in the specific field of inclusive education, and particularly within the scope of the External School Evaluation Programme (PAEE), there remains a need to deepen understanding of how external evaluation is mobilised by school leaders and translated into organisational and pedagogical practices [15]. The external evaluation of schools therefore constitutes a relevant process for understanding how school organisations recognise, organise and sustain responses oriented towards inclusion. The reference framework for the third cycle of the PAEE was updated in 2023 and is structured around four domains — Self-Evaluation, Leadership and Management, Provision of Educational Service and Outcomes — allowing for a multidimensional reading of school action [16]. This framework sets out indicators related to the improvement of inclusive education, the functioning of support structures and the orientation of educational action towards the Students' Profile by the End of Compulsory Schooling [16]. However, the ways in which school leaders appropriate this evaluative process to promote contextualised inclusive practices require further examination.

Thus, this article focuses on the external evaluation of schools as a process that can foster institutional reflection and the improvement of responses to diversity, seeking to answer the following research questions: (1) How do school leaders appropriate external evaluation as an instrument for reflection, regulation and improvement? (2) How is this appropriation translated into the organisation of inclusion-oriented responses, considering the emerging challenges associated with students' linguistic and cultural diversity?

2. Methodology

This study adopts a qualitative approach, with an interpretivist orientation, suited to understanding processes, meanings and practices in specific educational contexts [17]. A case study was chosen, centred on a cluster of state schools in mainland Portugal, as it enables an in-depth analysis of a complex educational phenomenon in its real-life context: the way in which school leaders appropriate the external evaluation of schools to guide processes of reflection, regulation and improvement in organisational and educational responses [18]. The school cluster was selected intentionally, considering its participation in the third cycle of the External School Evaluation Programme and the relevance of the challenges associated with the social, linguistic, and cultural diversity of its school population. The unit of analysis focused on the action of school leaders and on the ways in which they interpret, mobilise and translate external evaluation into decisions and practices oriented towards inclusion.

The empirical corpus comprised two main sources: i) the external evaluation report produced by the Inspectorate-General of Education and Science and key institutional documents from the school cluster, namely the Educational Project, the Internal Regulations, the Director's Intervention Project, the Self-Evaluation Report and strategic planning documents; and ii) semi-structured interviews with 12 teachers holding leadership roles. The participants included the director of the school cluster and 11 coordinators with pedagogical, organisational and/or strategic responsibilities. Participants were selected intentionally, focusing on key actors who, because of the roles they perform within the school cluster, have direct knowledge of leadership processes, the organisation of support measures, the implementation of inclusive practices and institutional responses to student diversity.

The interviews took place between December 2024 and March 2025, at times agreed with the participants. The interview guide was developed in line with the objectives of the study and organised around dimensions related to school leadership, the appropriation of external evaluation, the organisation of inclusive responses, pedagogical practices, engagement with the community and the challenges arising from linguistic and cultural diversity. The interviews were audio-recorded, fully transcribed and incorporated into the analytical corpus. Documentary analysis made it possible to contextualise participants' accounts and triangulate the evidence collected, thereby strengthening the interpretative consistency of the findings [19].

The data were analysed through thematic analysis, supported by MAXQDA software. The analytical process combined deductive and inductive logics: in a first stage, categories guided by the objectives of the study and the theoretical framework were considered, namely the strategic, organisational, pedagogical and community dimensions of inclusion; in a second stage, repeated reading of the transcripts and documents enabled the identification of emerging subcategories related to collaborative decision-making, the mobilisation of evaluation data, support for teaching practices, responses to students' needs, and linguistic and cultural diversity. Coding was conducted iteratively, with successive revision of the categories, comparison across sources and selection of representative excerpts, to ensure the internal coherence of the analysis and the traceability of interpretations [20,21]. The credibility of the study was ensured through source triangulation, peer review within the research team and validation of the findings with participants [22].

The interviews were conducted in Portuguese; the excerpts presented in this article were translated into English by the authors, preserving the original as closely as possible.

The ethical principles applicable to educational research were observed. Participants were informed about the objectives of the study, the voluntary nature of their participation, the possibility of withdrawal and the conditions of confidentiality. All participants signed an informed consent form. The data were anonymised by assigning alphanumeric codes to participants, and the identity of the school cluster was omitted. The processing, storage and analysis of the information complied with the General Data Protection Regulation, ensuring the protection of personal and institutional data [23].

The limitations of the study stem from the nature of the single case, which does not allow for statistical generalisation. However, the analytical depth of the study and the transferability of the interpretations to contexts with similar characteristics constitute relevant contributions to the field [18,22]. It is also important to acknowledge that this research focuses on the perceptions of teachers holding leadership roles and on documentary analysis, without seeking to measure the effects of inclusive practices on students' learning or experiences. Even so, the study makes it possible to understand how school leaders interpret and mobilise external evaluation in the organisation of educational responses that are more closely attuned to diversity.

3. Results and Discussion

Data analysis made it possible to understand how school leaders appropriate external evaluation, mobilising it to sustain processes of reflection, regulation of educational action and improvement of responses to student diversity. Triangulation between the external evaluation report, key institutional documents and interviews reveals a dynamic relationship between institutional evaluation, school leadership and inclusion. This relationship is neither linear nor uniform; it depends on how leaders interpret the data contained in the report, articulate them with self-evaluation and convert them into strategic decisions, pedagogical practices and monitoring processes.

The most recent IGEC report awarded the school cluster under analysis a rating of Good in the domains of Self-Evaluation and Outcomes, and Very Good in the domains of Leadership and Management and Provision of Educational Service. As strengths, the report highlighted consolidated self-evaluation procedures, leadership dynamics oriented towards the mobilisation of resources and partnerships, effective resource management, the diversity of educational provision, curricular options aligned with the principles of inclusive schooling and the effectiveness of measures promoting equity and inclusion. Simultaneously, the report identified areas for improvement related to the articulation between self-evaluation and strategic planning, internal reflection on academic outcomes, the involvement of students, families and non-teaching staff, internal and external communication, formative assessment, and collaborative supervision.

The analysis of the school cluster's key institutional documents shows that several of these dimensions were incorporated into planning. The Educational Project presents inclusion as a guiding axis of educational action, linking it to academic success, citizenship, students' holistic development, self-evaluation and continuous improvement. The Strategic Action Plan translates this orientation into measures aimed at promoting inclusion, recognising the heterogeneity of students and the need to further operationalise the measures provided for in Decree-Law No. 54/2018. In the same vein, the Director's Intervention Project revisits dimensions identified in the external evaluation and reorganises them as axes of action, distinguishing areas requiring improvement — such as the academic outcomes of certain groups of students, weaknesses in communication processes and the systematisation of formative assessment — from aspects to be strengthened or consolidated, such as the participation of the educational community in the construction of key institutional documents and the development of collaborative supervision practices.

Subsequently, following the characterisation of the participants, the results are presented and discussed according to four analytical dimensions: strategic, organisational, pedagogical and community. This organisation makes it possible to show how external evaluation is appropriated by school leaders across different levels of school action, from strategic planning to the construction of educational responses oriented towards the challenges arising from students' linguistic, cultural and social diversity.

3.1 Characterisation of Participants

The empirical study was conducted in the 2024/2025 school year in a school cluster that offered education from pre-school to the secondary level, attended by around 2,500 students, approximately 25% of whom were of foreign nationality.

The study involved 12 teachers holding leadership roles: the director and 11 coordinators of pedagogical, organisational and inclusion support structures. Each participant was assigned an alphanumeric code from P01 to P12 to ensure confidentiality. The detailed characterisation of the participants is systematised in Table 1.

Table 1. Characterisation of Participants

Code	Leadership role	Length of service	Age group
P01	Coordinator of class tutors in secondary education	31–35	> 61
P02	Coordinator of class tutors in the third cycle of basic education	21–25	41–50
P03	Special education coordinator	36–40	> 61
P04	Coordinator of class tutors in the second cycle of basic education	26–30	41–50
P05	Project coordinator	36–40	> 61
P06	Coordinator of the Multidisciplinary Team for Support to Inclusive Education	26–30	51–60
P07	School sports coordinator and chair of the General Council	26–30	51–60
P08	Coordinator of the first-cycle basic education department	31–35	51–60
P09	School libraries coordinator	41–45	> 61
P10	School cluster director	21–25	41–50

P11	Citizenship and development coordinator	21–25	41–50
P12	Self-evaluation team coordinator	36–40	> 61

Source: Authors' own elaboration

Taken together, the participants represent different levels of decision-making and coordination, encompassing senior leadership, middle leadership, inclusion support structures, self-evaluation, projects, the school library and engagement with the community. This diversity makes it possible to analyse inclusion as an organisational process involving strategic decision-making, internal coordination, pedagogical monitoring and relationships with the surrounding context.

3.2 Strategic Dimension: From External Evaluation to Planning

The strategic dimension reveals that external evaluation constitutes a reference point for the leadership and institutional management of the school cluster, although its impact depends on leaders' capacity to integrate its results into planning, self-evaluation and improvement processes. The IGEC report recognises the existence of self-evaluation and data collection procedures; however, it identifies the need for stronger articulation with strategic planning and internal reflection on the results.

This tension between data collection, reflection and action is clearly present in the internal documents. The Self-Evaluation Report conceives self-evaluation as a continuous process, aimed at assessing the performance of the school cluster and defining more effective forms of action. In this sense, the document assumes the intention to identify strengths and weaknesses, analyse outcomes and establish strategic action plans that promote a culture of continuous improvement.

In the interviews, school leaders revisit this dimension as a process of progressive appropriation. External evaluation offers an external perspective that enables the confirmation of strengths, the identification of weaknesses, and the legitimisation of change. P07, for example, values the IGEC report precisely because it offers an external, objective view that complements the self-evaluation team's perspective. This perspective is linked to the role assigned to that team in the Internal Regulations, whose existence makes it possible to understand external evaluation not merely as a one-off evaluative event, but as a source of information capable of feeding internal mechanisms of reflection, monitoring and decision-making. Similarly, P01 associates external evaluation with a moment of clarification and guidance, particularly in the context of implementing inclusive education policies after 2018. The participant states that the school cluster needed to understand what should be adjusted and that, following the evaluation, support documents and clearer guidelines for teachers were produced. This interpretation shows that external evaluation was appropriated as an instrument of internal regulation, helping to translate regulatory guidelines into concrete procedures.

However, this strategic appropriation of external evaluation does not remain linear over time. The director (P10) acknowledges that the IGEC reference framework was relevant when the report was received, but that it gradually lost centrality: "over time, it ended up fading into the background, as we are constantly confronted with new challenges (...) the COVID-19 pandemic, followed by the arrival of a large number of students from migrant backgrounds, including students of foreign nationality. The school is in permanent transformation, and we hardly have time to reflect on what we have already done" (P10). Qualitatively, P10's account is relevant because it reveals a central ambivalence: external evaluation legitimises improvement, yet its influence becomes fragile when schools face successive challenges and lack protected time for collective reflection. In this sense, external evaluation operates less as a fixed prescription than as a catalyst whose effects require continuity in internal routines of reflection, planning and monitoring.

The recent partnership with an external consultancy body to support the evaluation of the Educational Project, mentioned by P07 and P10, suggests a willingness to strengthen internal capacity for organisational analysis, drawing on initial external support as part of an empowerment strategy.

3.3 Organisational Dimension: Formal Structures and Distributed Responsibilities

The organisational dimension shows that the response to diversity is sustained by a network of structures, responsibilities and coordination mechanisms. The IGEC report had already recognised the school leadership as a cohesive, dynamic team, open to dialogue and capable of mobilising resources and partnerships, while also highlighting the existence of middle leadership structures suited to the educational responses required. It further valued the rational and equitable management of resources and the existence of an overall school environment that is safe, welcoming and inclusive.

The key institutional documents confirm this organisation. The Internal Regulations formalise specific resources to support learning and inclusion, including the Psychology and Guidance Service, Special Education teachers, the Multidisciplinary Team for Support to Inclusive Education (EMAEI), the Learning Support Centre, the Reference School for Early Intervention and other forms of support. This organisational architecture shows that inclusion is institutionalised through formal structures, whose implementation depends on the articulation between these structures and teachers' practices.
The interviews make it possible to understand how this organisation is operationalised. The director (P10) emphasises that the enactment of inclusive practices depends on the involvement of middle leaders and teachers, recognising that initiatives designed by the leadership only become effective when they are appropriated by the actors responsible for implementing them.
This idea is central to interpreting leadership as a distributed process. The action of leaders is not limited to defining guidelines; it involves coordination, listening, the mobilisation of resources, the negotiation of solutions and the monitoring of responses. Inclusion is thus presented as a shared organisational responsibility, requiring a chain of mediation between the leadership team, coordinators, class councils, EMAEI, Special Education, teachers, families and external partners. The EMAEI emerges as a decisive structure in this mediation. P06 describes an ongoing process of document review, monitoring of measures to support learning and inclusion, reorganisation of the Learning Support Centre, and mobilisation of teachers from different subject areas to respond to students' specific needs.
The organisational dimension is also evident in the work of the coordinators of class tutors, who act as mediators among class councils, the leadership team and support structures (P01, P02, P04). These coordinators follow cases, guide procedures and contribute to the early identification of needs. This articulation is particularly important in a large school cluster, where the circulation of information may constitute both a condition for effectiveness and a source of vulnerability.
Despite the existence of these structures, the data reveal persistent limitations. P12 considers that the EMAEI seeks to address needs, but the lack of human resources prevents an effective response. This finding is consistent with the pressure felt by other participants regarding the shortage of psychologists, operational assistants, specialised teachers and available time for monitoring and support. Thus, the organisation of inclusive responses depends on formal structures, but also on material and human conditions that do not always keep pace with the growth of needs. This constitutes a key organisational tension: formal structures signal institutional commitment to inclusion, but they do not by themselves guarantee effective capacity for response.
In this scenario, external evaluation makes organisational strengths and weaknesses visible. The external evaluation report values leadership, resource management and partnerships, but also identifies communication and the involvement of different actors in the school cluster's strategic definition as areas for improvement. The interviews show that investment was made in meetings, internal coordination, monitoring documents and consultation with the community, while also acknowledging that the increasing complexity of the school population requires more rigorous, agile and sustained coordination.

3.4 Pedagogical Dimension: Inclusive Responses, Assessment and Classroom Practices

The pedagogical dimension makes it possible to analyse how strategic and organisational guidelines are translated into teaching, assessment and student monitoring practices. The IGEC report recognised as strengths the diversity of educational provision, participation in projects that consolidate curricular autonomy and flexibility, the articulation of learning, collaborative practices among teachers and curricular options consistent with the primacy of inclusive schooling. However, it identified two areas for improvement that are particularly relevant to the transformation of pedagogical practice: deepening formative assessment and developing systematic procedures for monitoring and regulating teaching practice, including shared observation within a logic of collaborative supervision.
The Strategic Action Plan confirms that inclusion was translated into concrete pedagogical measures. The Action Plan for Inclusion identifies student heterogeneity and different modes of access to learning as a problem, defining as objectives the improvement of student success, the dissemination of available support resources to the community and the empowerment of students for integration into active life. Among its targets, particular emphasis is placed on ensuring co-teaching in Portuguese and Mathematics in classes with students identified as requiring selective measures.
The interviews show that this orientation is implemented through measures, pedagogical differentiation, in-class support, tutoring, the Study Room, Study Support, projects and coordination among teachers. P01 refers to the use of shared grids in class councils to identify difficulties and measures to be applied, enabling more timely intervention. P07 also describes the existence of diversified responses, such as in-class support, tutoring, mentoring and other forms of support, advocating flexible management

centred on students' characteristics. Inclusion is thus understood as a monitoring process that adjusts available resources to each student's specific needs, requiring coordination between diagnosis, intervention and monitoring. However, it is in this dimension that tensions become most evident. Although formative assessment is recognised as a priority, it emerges in the interviews as a practice still undergoing consolidation. P11 states that, following the external evaluation, the school cluster sought to strengthen formative assessment practices, although the process was marked by difficulties and some resistance from teachers: "We sought to implement some measures, namely regarding student assessment, but it has been a difficult process" (P11). This excerpt is analytically significant because it suggests that pedagogical change is not experienced merely as a technical adjustment, but as a demanding reconfiguration of assessment cultures, professional routines and shared responsibility for learning.

This tension is also visible in the Director's Intervention Project, which identifies the lack of systematic use of formative assessment as a feedback instrument for students and the absence of collaborative supervision oriented towards improving teaching practices as problems. The fact that these problems are included in the director's strategic diagnosis confirms that the areas for improvement identified by IGEC were appropriated within strategic planning, even though they remain challenges in terms of implementation.

Thus, the pedagogical dimension reveals a gap between the existence of guidelines and the effective transformation of classroom practices. External evaluation contributed to legitimising priorities such as formative assessment, differentiation, supervision and the regulation of practices, but their implementation depends on time, training, resources, collaboration and continuous professional development. Pedagogical change therefore appears to be slower and more demanding than documentary or structural reorganisation. This gap makes visible the tension between declared inclusion and lived inclusion: the existence of policies, documents and leadership intentions is necessary but insufficient when classroom practices and assessment cultures are not consistently transformed.

3.5 Community Dimension: Linguistic and Cultural Diversity as an Organisational Challenge

The community dimension is particularly prominent in participants' accounts. The IGEC report had already noted that, despite investment in the teaching and learning processes of students from migrant backgrounds, namely through the provision of PLNM and pedagogical support, outcomes remained below the desirable level. The Director's Intervention Project revisits this weakness, identifying the school outcomes of these students as a challenge to be overcome.

In the interviews, the director states that the school cluster welcomes around 600 students of foreign nationality, with particularly marked growth over the last three years, characterising diversity and multiculturalism as "the greatest challenge" (P10). P01 corroborates this interpretation, describing the increase as a sudden and intense change, and listing concrete difficulties: the concentration of several students of foreign nationality in the same class, the need to adjust curricula, the management of PLNM and the gap between students' prior knowledge and curricular requirements, particularly in years subject to national examinations. The response to this challenge has involved strategic and organisational readjustments. The director refers to the revision of initiatives such as linguistic and cultural mentoring, aimed at supporting newly arrived students, as well as the allocation of mentors by the Ministry of Education, interpreted as a response to the growth in the number of students of foreign nationality and to the demands of their academic and sociocultural integration. However, participants are also clear that some of these responses are improvised, particularly in situations requiring immediate action. Recalling the arrival of refugee students, P07 observes: "in many situations, we acted almost like a 'fire brigade', trying to solve problems as they arose. Goodwill and mutual help were fundamental, but we cannot regard that as an effective management model. What is needed are well-defined procedures" (P07). The school library also emerges as a relevant structure in this process: P09 describes it as a space "of everyone and for everyone", oriented towards welcoming students and promoting intercultural activities. This account points to the need to move from reactive problem-solving to more institutionalised, anticipated and collectively shared procedures.

This dimension shows that linguistic and cultural diversity is not merely a pedagogical challenge, but also an organisational and community issue, involving welcoming practices, communication with families, cultural mediation, language support, curriculum management and articulation with local partners. However, family involvement remains fragile, being recognised by the director (P10) as one of the main challenges, particularly in the more advanced stages of schooling, in line with the area for improvement identified by IGEC concerning the need to strengthen the participation of parents/guardians, students and non-teaching staff in the school cluster's strategic choices.

4. Conclusions

This study made it possible to understand how, in this case, school leaders appropriated the external evaluation of schools to guide institutional reflection, regulate educational action and improve responses to student diversity. In the case analysed, this appropriation was reflected in the definition of priorities, the reorganisation of support structures, the valuing of middle leadership and the monitoring of educational responses. In this process, school leaders mobilise different dimensions of school action – strategic, organisational, pedagogical and community – to sustain responses that are more closely attuned to student diversity. However, these processes are still undergoing consolidation and require stronger articulation between external evaluation and self-evaluation, strategic planning and the monitoring of pedagogical practices.

Inclusion emerges as a collective process, constructed through the articulation between senior leadership, middle leadership, teachers, specialised structures, families and external partners. Linguistic and cultural diversity emerges as a particularly significant and growing challenge, showing that inclusion requires institutional, pedagogical and community conditions capable of sustaining the participation, learning and development of all students. The findings caution, however, against celebratory readings: where time for reflection, resources and family engagement fall short, inclusion risks remaining a declared principle rather than a lived practice – a risk that grows as diversity increases faster than the conditions required to address it.

It is concluded that external evaluation acquires its true meaning when appropriated by school leaders as an instrument of reflection, shared responsibility and situated organisational transformation. Its relevance lies not only in the diagnosis it produces but also in how it is transformed into empowered action. Its impact is therefore mediated by leadership practices, organisational conditions and the capacity to convert evaluative evidence into situated and sustained action. It is through this movement that school leaders can strengthen the school's capacity to respond to diversity in a more responsive, equitable and committed way, promoting the educational success of all students.

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Cognitive Accessibility in Inclusive Art Education: A Cognitive Science Perspective on Students with Learning Differences

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Abstract

Drawing upon core principles from the field of cognitive science, this paper explores how pedagogical practices can be restructured to better serve students who demonstrate atypical learning patterns. The main argument is that inclusion should not stop at physical placement in the classroom. What matters is also whether students can actually reach, work with and express what is being taught. By examining cognitive mechanisms such as selective attention, encoding, retention, comprehension, and knowledge articulation, educators can uncover obstacles that remain concealed beneath seemingly typical classroom engagement. The essay uses the concept of cognitive accessibility and places it within art education, a subject where learning often depends on visual interpretation, symbolic meaning, memory, planning and creative expression. It examines dual coding, concrete examples, retrieval practice, elaboration and spaced practice as possible design principles for inclusive teaching. At the same time, it does not treat cognitive science as a complete answer. It needs to be read together with Universal Design for Learning, culturally responsive teaching and more critical views of inclusion.

Keywords: *cognitive science; inclusive teaching; learning differences; cognitive accessibility*.

1. Introduction

Inclusive education cannot be reduced to students sharing the same classroom space. A learner might sit among peers and complete the assigned activity, yet still remain outside the real learning process. This situation typically arises when instructional designs implicitly presuppose that every learner absorbs content, structures thoughts, and expresses comprehension through uniform modalities. For learners with different cognitive needs, the obstacle is not always the diagnosis itself. It can be created by the teaching design: instructions given all at once, examples that are not clear enough, weak connections with prior knowledge, or a response format that leaves little room for difference.

The present paper contends that insights derived from cognitive science enable educators to refine inclusive pedagogy by positioning cognitive accessibility as a foundational principle in curriculum planning. Cognitive accessibility means arranging learning so that students with different cognitive profiles can access, process, remember and communicate knowledge. It is not about making the work easier. Instead, the paper explores the means by which rigorous academic objectives can be achieved via well-structured content progression, intentional material presentation, scaffolded rehearsal, and actionable feedback tailored to learners' needs. This view is close to inclusive approaches that plan for learner diversity from the beginning (Schmidt & Harriman, 1998). It also connects with UDL as a form of anticipatory design (Sewell et al., 2022), and with Kennette and Wilson's (2019) view that UDL removes learning barriers from the outset rather than adding support only after problems appear.

I develop this argument through art education. At first glance, art lessons can seem naturally inclusive because they involve images, materials and some degree of choice. But this can be a little misleading. Art learning is not only about making things. It also asks students to interpret, remember, plan and communicate meaning. An activity that appears open-ended and imaginative may nonetheless prove challenging to engage with unless learners receive guidance in linking observed elements to the conceptual understanding and outputs that are required of them. Inclusive art education therefore needs both parts: space for creative freedom, and enough cognitive structure to help students move from seeing, to understanding, to making.

2. Reframing Learning Differences as Cognitive Accessibility

2.1 From Physical Inclusion to Cognitive Accessibility

Learning differences should not be treated as fixed labels or simple measures of ability. Students differ in many ways: attention, memory, language, processing speed, planning, confidence and expression. A cognitive perspective is useful because it shifts attention away from broad labels and towards the points where learning tasks become unnecessarily difficult.

This change also reshapes the question of what inclusion means in practice. It is not enough for students to take part in the same classroom activity. The activity also has to offer a possible path into the concept being taught. One learner may finish the assigned work yet fail to grasp the underlying concept the activity was designed to cultivate. A second pupil, conversely, might comprehend the intended notion but encounter difficulty articulating that knowledge through the specific format selected by the instructor. In both situations, the difficulty does not belong only to the student. It is also linked to the way the task has been designed. The path into learning may be too limited, or the method for showing learning may not match what the student is actually able to communicate.

It also challenges support that begins only after failure. When help is added at the end, the original design remains untouched. Aleven and Koedinger (2000a) show that students do not always know when they need help or use support effectively when it is left entirely to them. The wider implication is clear: inclusive teaching should embed support from the beginning rather than rely on students to request it.

2.2 Hidden Cognitive Barriers in Learning

Several cognitive barriers are relevant here. Long explanations, crowded slides or loosely organised tasks can make attention harder to hold. When students have to remember instructions, read examples, handle materials and make choices at the same time, working memory may become overloaded. Sweller (1988) argues that learning can be hindered when problem solving places heavy cognitive load on limited processing capacity. From the perspective of inclusive pedagogy, this indicates that challenges may originate as much from how a task is constructed as from the individual characteristics of the learner. Memory, retrieval and executive function also matter, since students need to bring earlier knowledge back into use while planning and monitoring complex work.

These barriers are not limited to students with learning differences, but these students may experience them more sharply. They are also easy to misread. A pause may mean processing, not disengagement. A short answer may show difficulty organising language, not lack of understanding. A simple artwork may suggest that the link between concept, material and outcome has become unclear. Consequently, effective inclusive pedagogy must examine the cognitive architecture underpinning tasks, instead of evaluating learners solely on the basis of their end-product performance.

Cognitive accessibility does not remove difficulty. It separates meaningful challenge from avoidable confusion. Teachers can sequence explanation, reduce split attention, clarify expectations, combine visual and verbal information, build in recall and provide structures for planning and explanation. The goal is not easier learning, but better designed access to demanding learning.

2.3 Why Cognitive Accessibility Matters in Art Education

Art education makes this issue visible because artistic learning combines perception, interpretation, memory, decision-making and expression. In lessons involving cultural forms, students are not simply recognising a pattern or object; they are learning how visual forms carry social, historical and symbolic meaning. Fu (2025) treats arts and crafts appreciation as a matter of interpretation, and Sullivan (1993) similarly frames art education as meaningful, authentic, critical and pluralist rather than mere practical production.

The danger is that making can be mistaken for understanding. Studies of surface-level learning have demonstrated that learners are capable of generating accurate responses yet remain unable to articulate the underlying rationale (Aleven, Koedinger, Sinclair, & Snyder, 1998). Although the subject area is distinct, this observation holds relevance for art education: pupils can replicate a design or finish a project without grasping its cultural significance or conceptual foundation. Completion is therefore not the same as cognitive access.

A more inclusive art lesson makes the movement from seeing to understanding, and from understanding to expression, more visible. It does not impose one interpretation or restrict creativity. It clarifies what

students should notice, how form connects with meaning, how prior knowledge can be recalled and how creative decisions can be explained.

3. Cognitive Science as Inclusive Design Principles

Cognitive science is most useful for inclusive teaching when it functions as a design resource, not as a catalogue of techniques. Research on Cognitive Tutors shows how theories of cognition can inform instructional design through knowledge representation, practice, feedback and progression (Anderson et al., 1995). This essay uses that insight in a broader classroom sense: learning processes should shape inclusive design.

Weinstein, Madan and Sumeracki (2018) discuss dual coding, concrete examples, retrieval practice, elaboration and spaced practice. Here these strategies are organised around three design problems: access, memory and interpretation. This structure keeps cognitive science tied to barriers in learning rather than presenting it as a list of study tips.

3.1 Designing Access: Dual Coding and Concrete Examples

The first issue is access, or how students first meet new knowledge. Dual coding can help because it connects what students see with what they hear or read. In an art lesson, for example, a teacher might show an artwork, point out the focal area, mark contrast or rhythm, and briefly explain how these features guide attention. When cultural symbols are introduced, the image can be placed beside a few key words and a short explanation of its meaning. This is useful for students who find long verbal explanation difficult, and also for those who can see the image but need language to make sense of it.

Concrete examples give abstract ideas a visible form. Concepts such as symbolism, cultural identity or creative transformation are difficult if introduced only through general language. Hakka architecture, paper-cut designs, festival objects, traditional colours or local craft materials can become bridges between sensory experience and conceptual understanding when students observe, describe and discuss what they represent.

These strategies support inclusion only when aligned with the learning purpose. More images do not automatically improve access; crowded or decorative visuals may increase load. Examples can also encourage imitation if students are not guided to compare, question and apply them. As research on shallow learning suggests, learners may rely on surface features when teaching does not direct attention to underlying principles (Aleven et al., 1998).

3.2 Designing Memory: Retrieval Practice and Spaced Practice

The next issue is memory. Students cannot use knowledge if they cannot bring it back when they need it. In art education, for example, a cultural symbol introduced in one lesson may return later in a sketch, a discussion, or a final piece of work. Retrieval practice asks students to recall information, rather than simply look over it again (Weinstein et al., 2018). In an inclusive lesson, this does not need to feel like a test. It can be simple and low-pressure: sketching a symbol from memory, recalling the steps of a technique, naming features of an art style, or explaining an idea briefly to a classmate.

Spaced practice supports this process by returning to content over time. Instead of presenting a cultural idea once, the teacher can revisit it through observation, visual analysis, sketching and later transformation. Each return allows students to reconstruct understanding in a different form.

For students with learning differences, retrieval and spacing reduce the expectation that everything must be understood and remembered immediately. They also support transfer. Yet they should not become mechanical repetition; each return should add meaning, moving from recognition to explanation, application and creative transformation.

3.3 Designing Interpretation: Elaboration and Self-Explanation

The third problem is interpretation. Studies of surface-level learning have demonstrated that learners are capable of generating accurate responses yet remain unable to articulate the underlying rationale (Aleven, Koedinger, Sinclair, & Snyder, 1998). Although the subject area is distinct, this observation holds relevance for art education: pupils can replicate a design or finish a project without grasping its cultural significance or conceptual foundation.

Problem-solving research supports this point. Ahlum-Heath and Di Vesta (1986) found that conscious verbalisation can support transfer by making reasoning explicit. Aleven and Koedinger (2002) likewise

found that students who explained their problem-solving steps developed stronger understanding and performed better on transfer tasks. Explanation is therefore part of learning, not merely a report after learning.
In art education, students should be supported not only to make an artefact, but to explain their choices. Questions such as why a particular symbol was chosen, how a given form connects to a cultural concept, what modifications have been made relative to the source material, and what significance the final piece conveys can shift learners from mere execution toward genuine comprehension.
Such explanation still requires support. Open questions can invite rich thinking, but may overwhelm students who need linguistic or conceptual scaffolding. Aleven and Koedinger (2000b) show that useful self-explanation often depends on feedback and dialogue. Sentence starters, labelled examples, visual prompts, comparison tables and group discussion can make explanation an accessible practice rather than another barrier.

3.4 From Techniques to Design Logic

The value of cognitive science does not lie in a fixed package of methods. Its stronger contribution is a design logic. Dual coding and concrete examples support access; retrieval and spaced practice support memory; elaboration and self-explanation support interpretation. Together, they form a sequence from noticing to understanding, remembering, explaining and creating.
This design logic connects cognitive science with inclusive education. Weinstein et al. (2018) show that learning depends on how knowledge is encoded, retrieved, elaborated and revisited. Aleven and Koedinger (2002) show that deeper understanding is more likely when learners explain reasoning rather than only complete tasks. Inclusive teachers should therefore ask not only whether students participate, but whether participation builds organised and communicable understanding.
This view also connects with UDL, which emphasises multiple means of engagement, representation, action and expression (Sewell et al., 2022). Cognitive science explains why such flexibility matters: different forms of representation and expression reduce different cognitive barriers. Used in this way, cognitive science does not reduce ambition; it clarifies where a lesson pressures attention, memory, retrieval, interpretation or expression.

4. Applying Cognitive Science to Inclusive Art Education

4.1 From Visual Observation to Guided Noticing

The first application is to make visual observation more guided. Students are often told to “look carefully”, but that instruction can be too open to help. A cognitively accessible lesson needs to show what careful looking involves. The teacher might draw attention to line, colour, texture, proportion or rhythm, and then add a short verbal explanation for each feature. When looking at Hakka architecture or a local craft object, students could first notice repeated forms, then consider how these forms connect with use, belief or community memory. In this way, dual coding gives observation some structure, but it does not replace interpretation. Students are not just shown an image and left to work it out alone. They are helped to notice what matters, and why it may matter.

4.2 From Cultural Symbols to Interpretation

A second application concerns cultural symbols. Students may recognise a motif, a colour or a detail in a building without really understanding its historical meaning. So inclusive art teaching needs to help them move from recognition to interpretation. Concrete examples should not be treated as models to copy. They work better as materials for comparison, questioning and meaning-making. Students might compare several motifs, notice shared visual qualities, and then discuss how these qualities connect with social context. A second application concerns cultural symbols. Students may recognise a motif, a colour or a detail in a building without really understanding its historical meaning. So inclusive art teaching needs to help them move from recognition to interpretation. Concrete examples should not be treated as models to copy. They work better as materials for comparison, questioning and meaning-making. Students might compare several motifs, notice shared visual qualities, and then discuss how these qualities connect with social context.
Vavrus (2008) reminds us that teaching needs to take culture seriously, rather than assume learners are culturally neutral. In art education, this means cultural examples should open up dialogue, not close it down with one fixed meaning. This matters because cultural knowledge is not simply information

handed from teacher to student. It is understood through students' own experiences, language and sense of identity.

4.3 From Memory to Creative Transformation

A third application is to connect memory with creative transformation. Students cannot reshape an idea if they cannot recall it. When a cultural notion is presented only once before being immediately succeeded by an unrestricted creative assignment, certain learners risk severing the connection between the original reference and their personal output. A more supportive sequence might move from observation, to recall, to comparison, then sketching and later adaptation. In this sense, retrieval and spacing are not rote repetition. They give students repeated chances to meet the same cultural idea at different levels of difficulty. Later making can then be guided by remembered meanings, rather than only by isolated visual effects. Cognitive support does not limit creativity; it gives students something firmer to think with when making independent choices.

4.4 From Single Output to Multiple Expression

The fourth application is to broaden expression. If assessment focuses only on a polished final artwork, some students may be unable to show the thinking that occurred during learning. UDL values multiple means of action and expression (Sewell et al., 2022). Learners may evidence their comprehension through labelled drawings, spoken justification, graphic organisers, brief reflective writing, collaborative dialogue, electronic montages, or a concluding artefact accompanied by documentation of the creative process. These are not easier alternatives; they are different routes for showing the relationship between form, meaning and intention. This also makes assessment fairer: the teacher can judge not only aesthetic finish, but the quality of interpretation, decision-making and reflection behind the work.

5. Critical Discussion

5.1 The Contribution of Cognitive Science

Cognitive science helps inclusive teaching by making the learning demands of a task easier to see. It asks what students are being asked to do with attention, working memory, retrieval, interpretation and expression. This matters in art education, where taking part and finishing a piece of work can sometimes look like understanding. But they are not always the same thing. Aleven and Koedinger (2002) are useful here because their study shows that learners often develop stronger understanding when they explain their reasoning, rather than only complete the task. In this sense, cognitive science supports a deeper kind of inclusion: one concerned with understanding and transfer, not just participation. Its role is not to remove difficulty from learning. It helps teachers decide which difficulties are meaningful, and which ones simply block access.

5.2 The Limits of a Cognitive Approach

At the same time, a cognitive account has obvious limits. Inclusion is not just about making information easier to process. It is also shaped by emotion, language, identity, culture, peer relationships and the wider conditions of the institution. Lindsay (2003) warns that inclusive education is too complex to be explained through simple claims about placement or teaching method. Even a meticulously planned lesson can prove exclusionary when it treats cultural knowledge as static, or when learners do not experience a sense of trust and validation within the classroom environment. Vavrus (2008) is useful here because he stresses the need for culturally responsive teaching. Cognitive accessibility, then, has to work alongside cultural responsiveness, care in classroom relationships and a critical awareness of power.

5.3 Cognitive Science and Universal Design for Learning

Cognitive science and UDL are complementary rather than interchangeable. UDL offers a broad framework through engagement, representation, action and expression; cognitive science explains why these forms of flexibility matter for learning processes. Yet UDL should not become a checklist. Kennette and Wilson (2019) found that students and faculty perceived many UDL elements as useful, but also note that perception data do not by themselves prove learning outcomes. A cognitively informed UDL

approach should ask which barriers a lesson creates, which forms of representation or expression address them, and how teachers will know that understanding has developed. In this sense, UDL provides the inclusive orientation, while cognitive science helps test the pedagogical logic of particular design decisions.

6. Conclusion

This essay has argued that cognitive science can inform inclusive teaching by shifting attention from physical presence to cognitive accessibility. Students with learning differences may be excluded because the learning pathway is narrow, overloaded or implicit. Cognitive science helps teachers identify these hidden barriers and redesign lessons so that students can access, retain, interpret and express knowledge more effectively.

Even a meticulously planned lesson can prove exclusionary when it treats cultural knowledge as static, or when learners do not experience a sense of trust and validation within the classroom environment. Dual coding, concrete examples, retrieval practice, spaced practice, elaboration and self-explanation can support this movement from noticing, to understanding, to remembering, explaining and creating. When applied thoughtfully in combination with UDL and culturally responsive pedagogy, insights from cognitive science have the potential to render inclusive art teaching both more intentional and more equitable across diverse learner profiles.

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Primary and Early Childhood Education

An Innovative Model for Mastering the Activity of Finding an Unknown Component in Equations in Primary School

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Abstract

One of the expected outcomes set out in the mathematics curricula for second, third, and fourth grades (general education) in the Republic of Bulgaria is the acquisition of skills for finding unknown addends and unknown multipliers (second grade), unknown minuend and unknown dividend (3rd grade), and unknown subtrahend and unknown divisor (4th grade).
This publication focuses on the acquisition of skills by 8-10-year-old students for finding unknown components in equations. Its aim is to present the author's model for teaching primary school pupils (aged 8-10) to effectively master the activity of finding unknown components in equations. To test the effectiveness of the model, a long-term pedagogical experimental study was conducted in the period 2022–2025, covering three consecutive school years. It involved 250 students, 125 of which in a controlled group and 125 students in an experimental group tracked from second to fourth grade, which allowed for an analysis of the sustainability and accumulation of results over time.
The analysis of the results obtained from this study shows that the implementation of the author's model in mathematics education of the experimental group from 2nd to 4th grade supports a more conscious and in-depth mastery of competencies for finding unknown components in equations.
The application of systematic training in finding unknown components also helps students aged 8–10 to apply these competencies more easily and effectively when solving problems for composing equations with unknown numbers in mathematical texts and when solving word problems.

Keywords: *primary school, mathematics, unknown component*

1. Introduction

The mathematics curricula for the primary stage of education in Bulgaria [1], [2], [3] provide for the derivation of rules for:

- finding an unknown addend and an unknown multiplier in second grade;
- finding an unknown minuend and an unknown dividend in third grade; and
- finding an unknown subtrahend and an unknown divisor in fourth grade.

The aim of the present publication is to present the author's approach to teaching primary school students to effectively master the activity of finding an unknown component in equations.
Different symbols, letters, etc. may be used to denote the unknown component. In primary school practice in Bulgaria, the most common way of denoting it is by means of an empty square (□).
Primary school students determine the unknown component in equations in two ways:

1. Based on their knowledge of arithmetic operations, by "guessing" the unknown number and checking whether their choice is correct;
2. Based on rules for finding the unknown component. These rules are formulated on the basis of the relationships between the components and the results of arithmetic operations that students have previously mastered.

2. Method

The aim of the present paper is to present an innovative teaching model for mastering the activity of finding an unknown component in equations by students at the primary stage of education.
The components of this innovative teaching model are presented in **Fig. 1.**

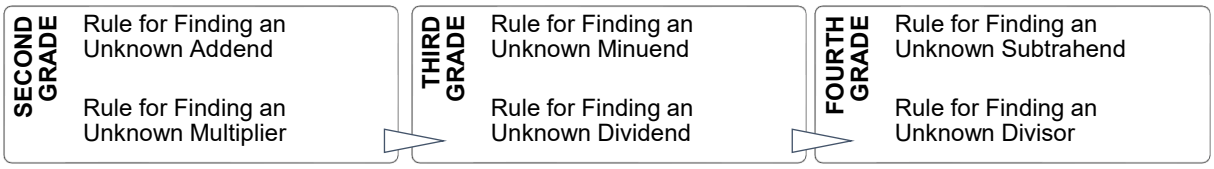


Fig. 1. Innovative teaching model for mastering the activity of finding an unknown component in equations.

2.1 Methodological Approach to Teaching the Rule for Finding an Unknown Addend

Finding an unknown addend by using the relationship between the components and the result in the operation of addition is a competence defined as an expected learning outcome in the mathematics curriculum for second grade [1]. The derivation of the rule is planned to take place within the general topic *Addition and Subtraction of Numbers up to 100 without Regrouping*.
It is appropriate for the methodological work to begin with the consideration of a problem on the basis of which the relationship between the components and the result in the operation of addition can be reached. To discover this relationship, the following problem is proposed:
Example 1. Compose a word problem based on the picture.



The picture is examined and analyzed. The teacher needs to emphasize the number of doughnuts that the boy and the girl place on the table and guide the students toward composing problems that are modeled by the expressions shown to the right of the picture.
Clarification: There are 23 blue doughnuts on the boy's tray and 10 pink doughnuts on the girl's tray.
Based on the illustration and the mathematical expressions, three-word problems can be composed: one that is solved by addition and two that are solved by subtraction. The problems are as follows:

a) *Georgi serves 23 blue doughnuts on the table, and Ani serves 10 pink doughnuts. How many doughnuts are there on the table altogether?*
b) *There are 33 doughnuts on the table. Of these, 10 are pink, and the rest are blue. How many blue doughnuts are there?*
c) *There are 33 doughnuts on the table. Of these, 23 are blue, and the rest are pink. How many pink doughnuts are there?*

The solutions to these word problems are as follows:

a) 23 + 10 = 33 (doughnuts altogether);
b) 33 – 10 = 23 (blue doughnuts);
c) 33 – 23 = 10 (pink doughnuts).

The three resulting interconnected equations are examined and analyzed. The discussion, aimed at identifying the position of the same numbers, leads to the following generalization: *If one addend is subtracted from the sum, the other addend is obtained.*
The derived relationship is applied when finding the unknown number in the problem from the following example.

Example 2. Find the unknown addend.

16 + □ = 48

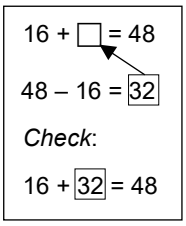


Fig. 2. Layout of the solution for problems involving the finding of an unknown addend.

By using the relationship between the components and the result in addition, the rule for finding an unknown addend is derived: *The unknown addend is found by subtracting the known addend from the sum.*

It is appropriate to reinforce this rule through problems in which an equation with an unknown addend is composed on the basis of a given mathematical text (Example 3) and through word problems that are modeled by an equation with an unknown addend (Example 4).

Example 3. Find the number that was thought of.

Neli thought of a number. She added 42 to it and obtained 68. What number did Neli think of?

Example 4. There were several boxes of chocolates on a shelf. After 3 more were placed there, they became 25. How many boxes of chocolates were there on the shelf initially?

Solving mathematical and practical problems by composing an equation with an unknown addend is an activity suitable for improving students' ability to use the derived rule in different situations.

For the application of students' mathematical knowledge, it is appropriate to solve problems with a more complex structure, such as the one proposed in the following example.

Example 5. Find the number.

To which number should 32 be added in order to obtain the difference between the numbers 96 and 54?

The organization of problems of this type should be carried out in two stages: first, establishing the correctness of the equations written by the students, and then checking the correct application of the rule for finding an unknown addend and the formatting according to the model in Example 2**.**

2.2 Methodological Approach to Teaching the Rule for Finding an Unknown Multiplier

Finding an unknown multiplier by using the relationship between the components and the result in the operation of multiplication is a competence defined as an expected learning outcome in the mathematics curriculum for second grade [1]. The teaching of the rule for finding it is planned to take place within the general topic *Multiplication and Division Tables*.

It is appropriate for the methodological work to begin with the consideration of a problem on the basis of which the relationship between the components and the result in multiplication can be defined. To discover this relationship, the following problem may be used:

Example 6. Compose word problems based on the picture.



Based on the illustration, three problems can be composed: one that is solved by multiplication and two that are solved by division. Here are sample formulations of the problems:

a) *There are 3 daffodils in each of 4 vases. How many daffodils are there in the vases altogether?*
b) *Twelve daffodils are placed in vases, with 3 daffodils in each vase. In how many vases are the daffodils placed?*
c) *Twelve daffodils are placed equally in 4 vases. How many daffodils are there in each vase?*

The solutions to these word problems are as follows:

a) 4 x 3 = 12 (daffodils altogether);
b) 12 ÷ 3 = 4 (vases);
c) 12 ÷ 4 = 3 (daffodils in one vase).

The three resulting interconnected equations are examined and analyzed. The discussion, aimed at identifying the position of the same numbers, leads to the following generalization: *If we divide the product by one of the multipliers, we obtain the other multiplier.*
The derived relationship is applied when finding the unknown number in the problem from the following example.

Example 7. Find the unknown multiplier.

□ x 4 = 20

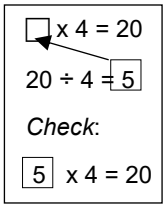
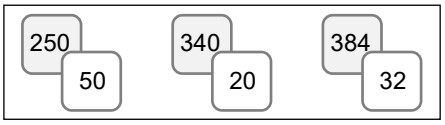


Fig. 3. Layout of the solution for problems involving the finding of an unknown multiplier.

By using the relationship between the components and the result in multiplication, the rule for finding an unknown multiplier is derived: *The unknown multiplier is found by dividing the product by the known multiplier.*
This is followed by solving a sufficient number of problems, such as those in Example 7, in order to help students make sense of the knowledge related to finding an unknown multiplier.
The problems for reinforcing and improving the skill of finding an unknown multiplier are analogous to those presented in section 2.1**.**

2.3 Methodological Approach to Teaching the Rule for Finding an Unknown Minuend

Finding an unknown minuend on the basis of the relationship between the components and the result in the operation of subtraction is a competence defined as an expected learning outcome in the mathematics curriculum for third grade [2]. The teaching of the rule for finding an unknown minuend is planned to take place within the general topic *Addition and Subtraction of Numbers up to 1000 without Regrouping*.
It is appropriate for the methodological work to begin with the consideration of a problem on the basis of which the relationship between the components and the result in the operation of subtraction can be clarified. To discover this relationship, the reasoning involved in solving the problem from the following example is proposed.
Example 8. Calculate the difference between the two numbers written on the cards and check it by addition.



As early as first grade, students know that the operation of addition can be used to check the operation of subtraction. According to the instructions for this problem, students should write three pairs of equations:

250 – 50 = 200, 340 – 20 = 320, 384 – 32 = 352,
200 + 50 = 250, 320 + 20 = 340, 352 + 32 = 384.

On this basis, after discussing the position of the same numbers in the equations, the following relationship is formulated: *If the difference is added to the subtrahend, the minuend is obtained.*
The derived relationship is applied when finding the unknown number in the problem from the following example.

Example 9. Find the unknown minuend.

□ – 30 = 100

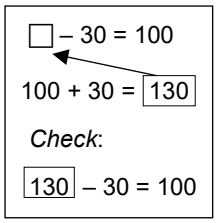


Fig. 4. Layout of the solution for problems involving the finding of an unknown minuend.

By using the relationship between the components and the result in subtraction, the rule for finding an unknown minuend is derived: *The unknown minuend is found by adding the difference and the subtrahend.*

This is followed by solving a sufficient number of problems, such as those in Example 9, in order to help students make sense of the knowledge related to finding an unknown minuend.

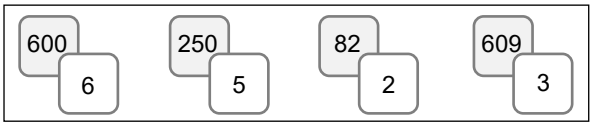
The problems for reinforcing and improving the skill of finding an unknown minuend are analogous to those presented in section 2.1**.**

2.4 Methodological Approach to Teaching the Rule for Finding an Unknown Dividend

Finding an unknown dividend on the basis of the relationship between the components and the result in the operation of division is a competence defined as an expected learning outcome in the mathematics curriculum for third grade [2]. The teaching of the rule for finding the unknown dividend is planned to take place within the general topic *Division of Two-Digit and Three-Digit Numbers by a One-Digit Number*.

It is appropriate for the methodological work to begin with the consideration of a problem on the basis of which the relationship between the components and the result in the operation of division can be clarified. To discover this relationship, the problem from the following example is suitable:

Example 10. Calculate the quotient of the two numbers written on the cards and check it by multiplication.



As early as second grade, students know that the operation of multiplication can be used to check the operation of division. According to the instructions for this problem, students should write four pairs of equations:

600 ÷ 6 = 100, 250 ÷ 5 = 50, 82 ÷ 2 = 41, 609 ÷ 3 = 203,
100 x 6 = 600, 50 x 5 = 250, 41 x 2 = 82, 203 x 3 = 609.

On this basis, after discussing the position of the same numbers in the equations, the following relationship is formulated: *If the quotient is multiplied by the divisor, the dividend is obtained.*

By using this relationship, the rule for finding an unknown dividend is derived in the following example.

Example 11. Find the unknown dividend.

□ ÷ 3 = 40

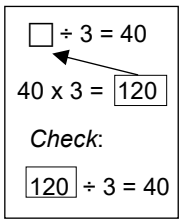


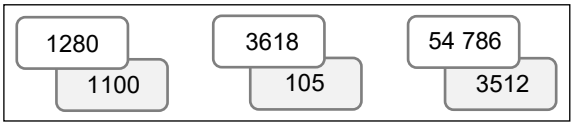
Fig. 5. Layout of the solution for problems involving the finding of an unknown dividend.

By using the relationship between the components and the result in division, the rule for finding an unknown dividend is derived: *The unknown dividend is found by multiplying the quotient by the divisor.*

This is followed by solving a sufficient number of problems, such as those in Example 11, in order to help third-grade students make sense of the knowledge related to finding an unknown dividend.
The problems for reinforcing and improving the skill of finding an unknown dividend are analogous to those presented in section 2.1.

2.5 Methodological Approach to Teaching the Rule for Finding an Unknown Subtrahend

Finding an unknown subtrahend by using the relationships between the components and the result in the operation of subtraction is a competence defined as an expected learning outcome in the mathematics curriculum for fourth grade [3]. The teaching of the rule for finding an unknown subtrahend is planned to take place within the general topic *Addition and Subtraction of Multi-Digit Numbers without Regrouping*.
The methodological work begins with the consideration of problems on the basis of which the relationships between the components and the result in the operations of addition and subtraction, studied in the previous grades and derived in the present paper in sections 2.1 and 2.3, respectively, can be updated. For this purpose, the problems from the following two examples are proposed.
Example 12. Calculate the difference between the two numbers written on the cards and check it by addition.



Example 13. Fill in the blanks by using the relationship between the operations of addition and subtraction.

6000 + 20 = 6020	15 204 + 3152 = 18 356
6020 – 20 = _____	18 356 – 3152 = _____
6020 – 6000 = _____	18 356 – 15 204 = _____

By using the relationships recalled in Example 12 and Example 13, two approaches to finding an unknown subtrahend are derived.

Example 14. Find the unknown subtrahend.

$3500 - \square = 1000$

It is appropriate to present the solution to this problem through the following two approaches:

First approach

$3500 - \square = 1000$

$1000 + \square = 3500$

$3500 - 1000 = \boxed{2500}$

Check:

$3500 - \boxed{2500} = 1000$

Second approach

$3500 - \square = 1000$

$3500 - 1000 = \boxed{2500}$

Check:

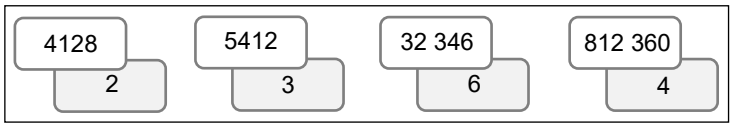
$3500 - \boxed{2500} = 1000$

In the first approach, the problem of finding an unknown subtrahend is reduced to a problem of finding an unknown addend, while in the second approach the following rule is derived: *The unknown subtrahend is found by subtracting the difference from the minuend.*
This is followed by solving a sufficient number of problems, such as those in Example 14**,** in order to help students make sense of the knowledge related to finding an unknown subtrahend.
The problems for reinforcing and improving the skill of finding an unknown subtrahend are analogous to those presented in section 2.1.

2.6 Methodological Approach to Teaching the Rule for Finding an Unknown Divisor

Finding an unknown divisor by using the relationships between the components and the result in the operation of division is a competence defined as an expected learning outcome in the mathematics

curriculum for fourth grade [3]. The study of the rule for finding an unknown divisor is planned to take place within the general topic *Division of a Multi-Digit Number by a One-Digit Number*.
It is appropriate for the methodological work to begin with the consideration of problems on the basis of which the relationships between the components and the result in the operations of multiplication and division, studied in the previous grades and derived in the present paper in sections 2.2 and 2.4, respectively, can be updated. For this purpose, the problems from the following two examples are proposed.
Example 15. Calculate the quotient of the two numbers written on the cards and check it by multiplication.



Example 16. Fill in the blanks by using the relationship between the operations of multiplication and division.

328 x 5 = 1640	3050 x 3 = 9150	10 900 x 7 = 76 300	65 020 x 8 = 520 160
1640 ÷ 5 = _____	9150 ÷ 3 = _____	76 300 ÷ 7 = _____	520 160 ÷ 8 = _____

Example 17. Find the unknown divisor.

$$8600 \div \square = 2$$

It is appropriate to present the solution to this problem through the following two approaches:

First approach

$8600 \div \square = 2$

$2 \cdot \square = 8600$

$8600 \div 2 = \boxed{4300}$

Second approach

$8600 \div \square = 2$

$8600 \div 2 = \boxed{4300}$

In the first approach, the problem of finding an unknown divisor is reduced to a problem of finding an unknown multiplier, while in the second approach the following rule is derived: *The unknown divisor is found by dividing the dividend by the quotient*.
This is followed by solving a sufficient number of problems, such as those in Example 17, in order to help students make sense of the knowledge related to finding an unknown divisor.
The problems for reinforcing and improving the skill of finding an unknown divisor are analogous to those presented in section 2.1**.**

3. Organization of the Study

A longitudinal pedagogical experimental study was conducted in the period 2022–2025. It covered three consecutive school years, with the students participating in the study being in second grade during the first year and in fourth grade during the final year. A total of 250 students from three schools in Plovdiv, Bulgaria, took part in the experiment: 125 in the control group (CG) and 125 in the experimental group (EG). The author's innovative model for the effective mastery of skills for finding an unknown component in equations was applied in the instruction of the students from the experimental group.
The aim of the present study is to create, apply, experiment with, and establish the effectiveness of the developed innovative model of mathematics instruction in second, third, and fourth grade.
Hypothesis: If the author's innovative model of mathematics instruction is applied in grades 2–4, it would contribute to mastering and deepening students' knowledge and skills for finding an unknown component in equations, as well as to developing the mathematical and logical thinking of students at the primary level of education.
The object of the study is the process of mastering the knowledge and skills for finding an unknown component in equations by students from second to fourth grade.
The subject of the study is the identification of the relationships between the specific features of the activities for finding an unknown component in equations and the degree to which students master them, depending on the developed and applied author's innovative teaching model.
In the course of the experimental study, the students from both groups were subjected to a diagnostic assessment at the beginning of the study. This assessment was used to determine the level of their

mathematical competencies at the beginning of second grade, which made it possible to divide the students into a control group and an experimental group. One diagnostic assessment was also conducted at the end of second, third, and fourth grade, respectively, in order to determine the level of mastery of the skills for finding an unknown component in equations acquired in the respective grade.
The effectiveness of the innovative model created and applied in the instruction was assessed at the end of each school year according to the following criterion: *Mastery of competencies for finding an unknown component in equations.*
The evaluation of the obtained results was carried out according to the following indicators:
First indicator. Knowledge of the rules for finding an unknown component in equations.
Second indicator. Composing an equation with an unknown component based on a given mathematical text.
Third indicator. Solving a word problem that is modeled by an equation with an unknown component.
The present publication focuses on the final diagnostic assessment conducted in fourth grade, after the completion of the instruction of the fourth-grade students from the experimental group according to the innovative model. This assessment was used to diagnose the level of students' mathematical competencies according to the three indicators defined above, both in the control group and in the experimental group. The diagnostic assessment was carried out after the study of the general topic *Division of a Multi-Digit Number by a One-Digit Number*.

4. Results

The following section presents and analyzes the results of the conducted final diagnostic assessment according to the three indicators formulated above.
With regard to the first indicator, "Knowledge of the rules for finding an unknown component in equations," the analysis of the results shows that 93.6% of the students from the EG know the specified rules, whereas the percentage of students from the CG who have acquired this knowledge is 75.2%. Knowledge of the rules for finding an unknown component in equations is a prerequisite for the successful solving of various types of problems involving the specified learning content.
As regards the second indicator, "Composing an equation with an unknown component based on a given mathematical text," the analysis of the results from the independent work shows that 87.2% of the fourth-grade students from the EG who participated in the study have mastered the specified skills. By comparison, the percentage of students from the CG who are able to apply their skills in the specified context is 68.8%.
With regard to the most complex activity, "Solving a word problem that is modeled by an equation with an unknown component," which is also the third indicator used to assess students' mathematical competencies, the students from the EG demonstrated high results, with 75.2% of the students having mastered this activity. By comparison, the specified competence was mastered by 56.8% of the fourth-grade students from the CG, who were not taught according to the presented innovative model.

5. Conclusion

The pedagogical observations carried out during the experimental study, which lasted for three consecutive school years, as well as the presented results from the conducted final diagnostic assessment, confirm the previously formulated hypothesis: "If the author's innovative model of mathematics instruction is applied in grades 2–4, it would contribute to mastering and deepening students' knowledge and skills for finding an unknown component in equations, as well as to developing the mathematical and logical thinking of students at the primary stage of primary education." The analysis of the results clearly shows that instruction supported by the author's innovative model helped the students from the EG apply the acquired competencies more easily and effectively when composing an equation with an unknown component based on a given mathematical text and when solving word problems that are modeled by an equation with an unknown component.
The implemented longitudinal pedagogical experimental study shows that systematic work involving the solving of a sufficient number of tasks, diverse in type, for applying knowledge and skills related to finding an unknown component in equations leads to a higher level of mastery of the specific mathematical competencies. This will undoubtedly have a positive impact on students' confidence and self-esteem in mathematics lessons.

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An Innovative Model for Teaching Mathematics and Social Studies through Game-Based Learning in Primary Education

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Abstract

This article explores the possibilities for implementing game-based approaches in primary education (Year 3). It presents an innovative teaching model that integrates the development of mathematical, social science and digital competences. The main goal of the proposed model is to transform the learning process into an active, attractive, and developmental experience for students.
The publication presents an interdisciplinary game-based lesson entitled "Journey into the Past." It helps third-graders summarize their knowledge and skills in mathematics and social studies related to global topics: "Addition and Subtraction of Numbers up to 1000 without Regrouping," "Addition and Subtraction of Numbers up to 1000 with Regrouping," "Multiplication of Two-Digit and Three-Digit Numbers by One-Digit Number," "Division of Two-Digit and Three-Digit Numbers by a One-Digit Number" and "Bulgarian Society in the Middle Ages". The methodological development emphasizes the development of digital competencies through working with QR codes and 360-degree technologies, which transforms the lesson into a comprehensive educational experience.
The introduction of such interdisciplinary game-based lessons in primary education will help to increase student motivation and promote more lasting acquisition of knowledge and skills in various subjects.

Keywords: *Game-Based Learning, Mathematics, Social Studies, Innovative Model*

1. Introduction

The rapid development of new technologies presents modern education with a range of opportunities and challenges linked to the demands of a radically different economic and social environment. There is a growing consensus that modern schools must prepare students for jobs that do not yet exist, to use technologies that have not yet been invented, and to solve problems we do not yet know exist. To address the challenges facing education, a number of international organisations are developing strategic frameworks and concepts, focusing on the development of soft skills, critical thinking and adaptability, and aiming to transform the student from a passive recipient of information into an active participant in the learning process and a creator of their own future. An example of such a document is the Organisation for Economic Co-operation and Development's framework – 'The Future of Education and Skills 2030/2040' [1], which is one of the most influential contemporary documents rethinking the role of schools in the dynamic 21st century. At the heart of this project lies the concept of the 'OECD Learning Compass 2030' [2]. The document clearly states that, in the face of an unpredictable future, schools can no longer offer students a fixed route (map), but must equip them with tools for self-navigation. This is why a 'compass' is needed, comprising: knowledge, skills, attitudes and values, to help students begin to apply their knowledge in practice so that they can succeed in life after school. To achieve these goals, the use of integrative learning resources linked to real-world practice and combining knowledge and skills from different subjects is becoming increasingly important.
Modern primary education requires that learning content be presented in an accessible, motivating and practical way that encourages curiosity, independent thinking and experiential learning. In this context, the cross-curricular links between social studies and mathematics offer rich opportunities for making sense of knowledge through solving practical and creative tasks related to time, space, numbers and social relationships.
This article presents an innovative model of teaching mathematics and social studies through game-based learning for Year 3. Many researchers share the view that combining a game-based framework with a didactic task offers a number of advantages, including: the development of teamwork skills, the building of positive motivation for learning, the filling of gaps in knowledge, the correction of errors, etc. [3].
The lesson presented in this publication is designed to consolidate the knowledge, skills and attitudes acquired from the following global topics: *"Addition and Subtraction of Numbers up to 1000 without*

Regrouping," "Addition and Subtraction of Numbers up to 1000 with Regrouping," "Multiplication of Two-Digit and Three-Digit Numbers by a One-Digit Number," "Division of Two-Digit and Three-Digit Numbers by a One-Digit Number" [4] and *"Bulgarian Society in the Middle Ages"* [5]. The interdisciplinary lesson is structured as a themed adventure in which students must find a traveller lost in time. To achieve this goal, they sequentially solve tasks related to historical events, geographical locations, performing arithmetic operations, applying logical thinking and navigating various situations. The lesson includes both practical tasks, as well as links to interactive games and 360-degree images, which transform the traditional revision session into an engaging educational mission.

2. Method

The aim of this article is to present an innovative teaching model for mathematics and social studies through game-based learning in primary education. The model was implemented with 96 students from four Year 3 classes in two primary schools in Plovdiv, Bulgaria, during the 2025–2026 academic year. The innovative model comprises six lessons combining the third-year curriculum for mathematics and social studies. Five of the lessons cover global topics from both subjects that were being studied at the time the lessons were delivered, whilst the sixth serves to summarise part of the curriculum at the end of the school year. The focus of this publication will be precisely on this summary lesson.

2.1 Structure of the Interdisciplinary Game-Based Lesson 'Journey Into The Past'

The theme of this innovative lesson revolves around a lost time traveller. By successfully completing the set tasks and educational games, Year 3 students will be able to find him and, subsequently, learn about the historical period in which he has found himself.
Following a motivating introduction to the lesson topic, the lesson is delivered in the following three stages:
Stage One: Discovering the location in Medieval Bulgaria where the traveller has ended up
The class is divided into teams of four third-year students. Each team receives a worksheet (**Fig. 1.**), containing six questions – three on mathematics and three on social studies. At the end of the worksheet there is a URL address which the students in the team must complete by entering, in sequence, the letters preceding the correct answers to the six questions. In this way, if the students make a mistake on any of the questions, the link will not be active. It will only open if they answer all six questions correctly across both subjects. The correctly completed web address will take them to the place where the traveller has gone missing. The link is generated via the *bit.ly* platform, which allows for free link shortening and the creation of QR codes.
The images used in the first task on the worksheet are taken from the 'Man and Society' textbook for Year 3, authored by R. Penin and G. Yakimov [6].

1. Which of the images is related to Medieval Bulgaria?



a) b) c)

2. What are the missing words in the text?

The Proto-Bulgarians believed in the god _____. They were led by _____ and lived in _____.

In _____ the Bulgarians, led by Asparuh, defeated Byzantium and created _____ Bulgaria.

a) Perun, Prince, dugouts, 681, Volga

b) Lada, king, palaces, 678, Old Great

c) Tangra, khan, yurts, 681, Danube

3. Examine the plan of the city of Preslav and determine in which direction the palace church is located in relation to the Royal Palace.



a) East

b) West

c) North

d) South

4. A medieval craftsman has 1 kilogram of gold. From it he needs to make 276 gold coins, each weighing 3 grams. How many grams of gold will he have left after making the coins?

a) 182 grams b) 172 grams c) 272 grams

5. During the week, 45 groups of 8 students visited the archaeological museum to see the Preslav Treasure, and on Saturday and Sunday – 25 groups of 6 students. How many students in total saw the treasure?

a) 510 students b) 410 students c) 500 students

6. The gift shop at the Archaeological Museum received 144 round magnets and 128 rectangular magnets. The round magnets were packed in boxes of 6, and the rectangular ones in boxes of 8. How many boxes were the magnets packed into in total?

a) 30 boxes b) 40 boxes c) 50 boxes

Link: www.□□□□□□.bit.ly

Fig. 1. Worksheet with a space to fill in a URL address.

Stage Two: A Journey into the Middle Ages

When they open the URL, they have found, the students will be taken to a 360-degree image of medieval Tarnovo (the capital of the Second Bulgarian Kingdom) (**Fig. 2.**). The panoramic image is hosted on the Study360.eu platform, which allows the use of 360-degree images for educational purposes and the creation of special info points with additional information at various locations within the image.

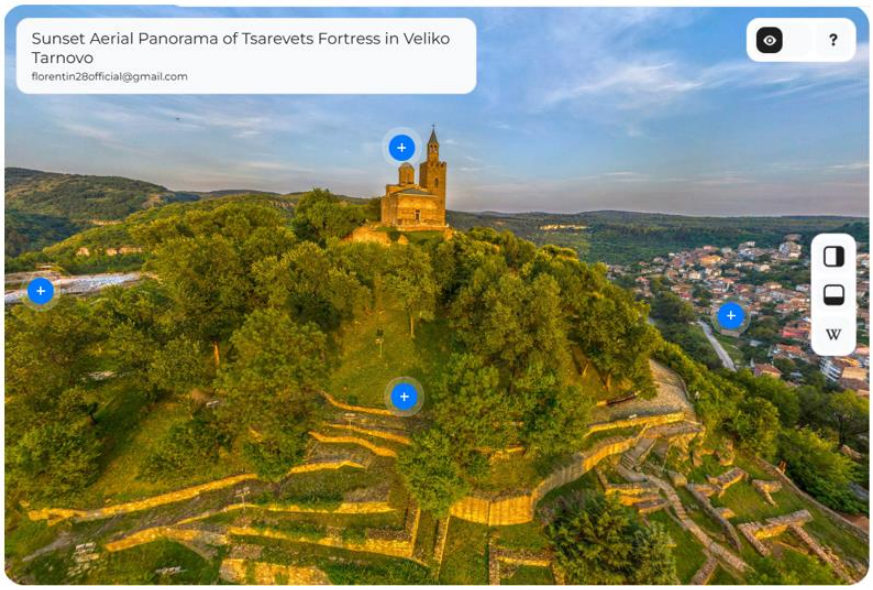


Fig. 2. 360-degree image of medieval Tarnovo.

The Middle Ages is the period in which the lost traveller finds himself. Six info points are located on the image of this old Bulgarian capital. Five of them contain information related to the overarching theme 'Bulgarian Society in the Middle Ages', which the Year 3 students need to recall, whilst the sixth info point contains a hidden link to the educational platform *LearningApps.org*.

Stage Three: In the footsteps of the lost traveller

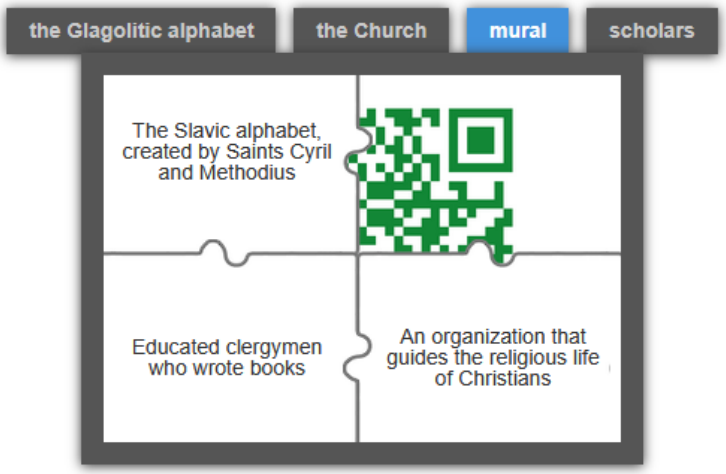


Fig. 3. Educational game on *LearningApps*.

The link that the Year 3 students discover in the 360-degree image takes them to an online educational game created using the 'Groups in a Puzzle' template on the *LearningApps.org* platform (**Fig. 3.**). In it, Year 3 students must match concepts and their definitions related to the information they recalled whilst exploring the 360-degree panoramic image. Correct completion of the game will reveal a QR code to the Year 3 students, which will take them to a talking avatar of the traveller (**Fig. 4.**). The image of the traveller itself was generated using *ChatGPT*, and the video in which he addresses the students was created using the free AI video generator *heygen.com*.



Fig. 4. Talking avatar.

Here are the words with which the traveller will greet the Year 3 students:
"Hurrah! You've found me! Thank you, brave time travellers! Whilst I was lost through the centuries, I found myself in the glorious days of the Bulgarian Middle Ages and learnt many important things!
I realised that Medieval Bulgaria was a powerful country, with an amazing culture, ruled by wise rulers. They protected the people, built impressive fortresses and monasteries, and made Bulgaria one of the leading countries in south-eastern Europe.
I also met various people from medieval society. I met boyars – the rich and important aides to the tsar; craftsmen – masters who made vessels, clothes and weapons; merchants – travelling to distant lands; and peasants – the largest part of the population, providing for the whole of society. All these groups played an important role.
I visited the beautiful capitals of Pliska, Preslav and Tarnovo, where I saw fortresses, palaces and churches. I also learnt that Saints Cyril and Methodius gave the Slavs an alphabet, and that their disciples found refuge in Bulgaria and continued the work of the Slavic apostles.

Remember: when a people are brave, hard-working, united and when they preserve their traditions, they remain strong, no matter the difficulties! And now it's time to head back… to your classroom!"

2.2 Development of Key Competences in the Interdisciplinary Game-Based Lesson "Journey Into The Past"

The varied system of educational activities in the "Journey into the Past" lesson supports the development of mathematical, civic and digital competences in Year 3 students.
According to the "Council Recommendation on key competences for lifelong learning", digital competence is defined as "the confident, critical and responsible use of and engagement with digital technologies for learning, at work and for participation in society" [7]. In the lesson presented, third-year students are given the opportunity to work with a variety of digital technologies – typing using a keyboard and opening a URL address, opening and navigating a 360-degree image, using information from info points within the image; navigating the *LearningApps.org* platform and participating in an online educational game, using a QR code scanning app to access a talking avatar generated using AI.
In the same document, mathematical competence is defined as 'the ability to develop and apply mathematical thinking and perspective in order to solve various problems in everyday situations' [7]. The maths tasks included in the worksheet used at the start of the lesson support the development of third-year students' mathematical competences by placing them in practical problem situations that can be solved using the tools and language of mathematics.
One of the aspects of civic competence emphasised in the Recommendation of the Council of the European Union is "awareness of current events and a critical understanding of the major events in national, European and world history" [7]. The concepts, facts and information on key events included in the various stages of the interdisciplinary lesson, studied under the topic *'Bulgarian Society in the Middle Ages'*, directly correspond to the values of European society, including a good knowledge of national history.

2.3 Challenges and Opportunities for Development in the Implementation of the Innovative Teaching Model

Possible challenges to the integration of the author's teaching model include the need for a stable internet connection, which is not always available in some schools, as well as the high level of skills required of the teacher to create such types of teaching materials.
The model also has potential for development in several directions. The technical aspect could be enhanced by integrating an AI-powered chatbot, with which students could converse in real time on various historical issues. The interdisciplinary nature could be deepened by integrating further subjects such as Bulgarian language and literature (through the analysis of various texts) or art (by redrawing parts of the 360-degree panoramic photographs; drawing objects from a particular era).

3. Survey

Following the conclusion of the implementation of the innovative model of game-based learning, a survey was conducted with the students from the four Year 3 classes included in the study. The aim was to ascertain the Year 3 students' views regarding their mastery of the curriculum content through game-based lessons.
Survey:
1. Select the statement that applies to you.
    - Game-based lessons made it easier for me to understand the maths material.
    - Game-based lessons made it harder for me to understand the maths material.
    - It was neither easier nor harder for me to understand the maths material.
2. Select the statement that applies to you.
    - The game-based lessons made it easier for me to understand the social studies material.
    - With the game-based lessons, I found it harder to understand the social studies material.
    - It was neither easier nor harder for me to understand the social studies material.
3. Select the statement that applies to you.
    - I found it easy to work with the photos and games on the phone/tablet.
    - I found it difficult to work with the photos and games on the phone/tablet.
    - It was neither easy nor difficult for me to work with the photos and games on the phone/tablet.
4. Select the statement that applies to you.

- I found the game-based lessons very interesting.
- I found the game-based lessons somewhat interesting.
- I didn't find the game-based lessons interesting.

5. Select the statement that applies to you.
   - I would like there to be more game-based lessons.
   - I would like there to be fewer game-based lessons.

With regard to the acquisition of maths learning material during game-based lessons, 90.63% of Year 3 students stated that it was easier for them, 1.04% of those surveyed (one student) stated that it was more difficult for them, whilst 8.33% saw no difference compared to traditional lessons.
As for the assimilation of social studies material, 92.71% of the third-year students surveyed noted that it was easier for them to understand the material, whilst 2.08% encountered more difficulties. Of all those surveyed, 5.21% reported no difference in the ease with which they absorbed the teaching material compared to traditional lessons.
The result is not surprising when students are asked about the ease of working with digital technologies. Of the third-year students surveyed, 97.92% stated that they had not encountered any difficulties when working with the various online platforms, whilst only 2.08% stated that they had experienced some difficulties.
One of the major shortcomings highlighted when discussing traditional methods of teaching and the organisation of the learning process is the lack of emotional engagement and variety to spark students' interest. When asked for their opinion on the author's interdisciplinary lessons, 96.87% of those surveyed stated that they found them interesting, whilst the remaining 3.13% said they found them somewhat interesting. It is positive that none of the third-year students surveyed reported that their interest had not been sparked during the game-based lessons.
The responses to the final question in the survey were decisive for the overall opinion of the Year 3 students regarding the integrative game-based lessons – 98.96% of those who took part in the survey would like to have more such lessons, whilst only 1.04% (one student) would prefer there to be fewer.

4. Conclusion

The presented author's innovative model for interdisciplinary learning through a game-based approach successfully integrates the curriculum content for mathematics and social studies for Year 3, by transforming the traditional lesson into an engaging 'journey through time'.
The results of the questionnaire survey conducted among the four experimental classes confirm the high effectiveness of this approach – over 90% of the third-year students report that the game-based format has facilitated their understanding of the teaching material in both mathematics and social studies. Almost all respondents (96.87%) expressed a strong interest in the lessons, and working with modern technologies (QR codes, 360-degree images and AI avatars) is readily embraced by the students, which contributes to the development of their digital competence in line with contemporary trends in education. The implementation of such integrative learning resources not only aids in the more lasting acquisition of the competences set out as expected outcomes in the curricula, but also develops soft skills such as critical thinking, teamwork and adaptability, which are necessary for tackling the challenges of the 21st century.

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Study of Cases Involving Addition and Subtraction of Numbers Up To 100 without Crossing the 100-Mark Analysis of the Current State of Mathematics Textbooks for Secondary Schools Grade in Bulgaria

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Abstract

The recent reforms in the educational system in the Republic of Bulgaria and the subsequent updates to the mathematics curricula for grades 1–4 (general education) have led to the development and approval of textbooks aimed at building sustainable mathematical competencies in students. In this regard, the Ministry of Education and Science (MES) has approved nine mathematics teaching kits for compulsory education in second grade, developed by various teams of authors.
The aim of this article is to analyze the theoretical frameworks that substantiate the methodology for teaching the global topic "Addition and Subtraction of Numbers Up to 100 Without Crossing the Hundred-Mark," and to examine their implementation in the current mathematics teaching materials for second grade in the primary education stage. Emphasis is placed on the sequence of introducing new knowledge, the approaches used to clarify the algorithms for adding and subtracting numbers up to 100 without crossing the 100-mark, and the means of illustrating them. With a view to optimizing the learning process and assisting teachers in planning and implementing instruction, the study aims to highlight best practices and methodological solutions presented by the author teams. It also seeks to identify similarities and differences in the presentation of the global theme of mathematics in second grade.

Keywords: *elementary mathematics education; addition and subtraction of numbers up to 100 without carrying*

1. Introduction

In the early stages of primary education, mathematics instruction plays a fundamental role in developing logical and analytical thinking in students. More specifically, this involves mastering basic arithmetic operations (addition and subtraction), as well as the knowledge and skills acquired through them. These are key factors in developing confidence, a systematic approach, and competencies for solving practical real-life problems.
The curricula developed following the educational reform aim to bring Bulgarian educational standards into alignment with European ones. They serve as a regulatory framework that defines the learning objectives, curriculum content, and expected outcomes for each subject in every grade. Their primary task is to ensure a higher-quality and more competitive education.
The topics in the second-grade mathematics curriculum include specific expected outcomes and key concepts from various areas of competence. The focus is on building upon the arithmetic operations of addition and subtraction learned in first grade and developing knowledge and skills for multiplication and division using tables. One of the key focuses is the application of algorithms and techniques for performing addition and subtraction with numbers up to 100 without crossing the tens place.

2. Method

According to V. Angelova, "Cases involving addition and subtraction of numbers up to 100 can be grouped into two main categories:
First group. Adding a two-digit number to a one-digit or two-digit number when the sum of their ones and tens is less than ten; Subtracting a one-digit or two-digit number from a two-digit number when the sum of the ones and tens of the minuend is greater than that of the subtrahend.
Second group. Adding a two-digit number to a one-digit or two-digit number when the sum of their one digits is greater than or equal to ten, or the sum of their tens digits is ten; subtracting a one-digit or two-digit number from a two-digit number when the number of ones in the minuend is less than the number

of ones in the subtrahend; subtraction from 100." [5]
This article/publication aims to present the theoretical foundations and contemporary methodological approaches to teaching the topic *"Addition and Subtraction of Numbers Up to 100 Without Carrying*," as well as to analyze how these concepts are applied in current second-grade mathematics textbooks.
The methodology for teaching the arithmetic operations of addition and subtraction without crossing the 100-mark encompasses both oral and written techniques for performing calculations with natural numbers up to 100.
Written addition (and *subtraction*) is performed according to the following algorithm: first, the ones digits of the numbers are added (or subtracted), and then their tens digits.
Oral addition (or *subtraction*) starts with the tens, and there is some variation in the calculations. Arithmetic algorithms are taught within a specific system, with each subsequent concept being explained based on the previous ones.
First group. Adding a two-digit number with a zero in the ones place to a one-digit number; subtracting the ones or tens from a two-digit number (20 + 3; 23 — 3; 23 — 20).
Second group. Adding a two-digit number to a one-digit number and subtracting a one-digit number from a two-digit number (21 + 5; 26 — 5).
Third group. Adding two-digit numbers, one of which has a zero in the ones place. Subtracting a two-digit number with a zero in the ones place from any two-digit number (27 + 10; 37 — 10).
Fourth group. Adding and subtracting arbitrary two-digit numbers (32 + 26; 58 — 26).
Let's consecutively examine how these four groups of cases are implemented in the current second-grade mathematics textbooks. These are the mathematics textbooks published by:

- "Prosveta Plus" by authors V. Angelova and S. Doichinova [1];
- "Prosveta" by authors Y. Garcheva and A. Manova [4];
- "Bulvest" by M. Bogdanova, M. Temnikova, and V. Ivanova [3];
- "Anubis" by T. Vitanov, G. Kirova, Z. Sharkova, I. Pushkarova, and D. Parusheva [9];
- "Pythagoras" by I. Mincheva, M. Dimitrova, and R. Gernat [6];
- "Scorpio" by R. Petrova, R. Stoyanova, and P. Daskova [8];
- "Riva" by L. Alexieva and M. Kirilova [2];
- "Bit and Technology" by T. Vulkova, M. Vanikova-Rukhova, D. Stoyanova, D. Dimitrova, I. Dimitrova, V. Damaskova, and T. Lazarova [10];
- "Archimedes" by Z. Paskaleva, M. Alashka, P. Paskalev, and R.Alashka [7].

The reasoning involved in studying the **first group** of cases is as follows:

- The number consisting of 2 tens and 3 ones is 23. Therefore, 20 + 3 = 23.
- In the case of 23 — 3, we use the fact that the number 23 consists of 2 tens and 3 ones. Therefore, if we subtract 3 (i.e., 3 ones) from 23, we get 2 tens, i.e., the number 20.
- In the case of 23 — 20, we also use the fact that the number 23 is the sum of 2 tens and 3 ones. When 2 tens are subtracted from 23, 3 ones remain.

These cases are presented as separate lessons in the textbooks of the following publishers: "Prosveta Plus" [1], "Pythagoras" [6], "Bulvest" [3] and "Scorpio" [8] which allows for a more targeted introduction and understanding of the new knowledge.
In the textbook published by "Anubis" [9] these cases are combined with others from different groups into a single lesson, resulting in a more compact presentation but requiring a higher degree of abstraction and potentially making it more difficult for students to initially comprehend material.
In the textbook published by "Prosveta" [4], the content is divided into two separate lessons—one presenting the addition operation and the other the subtraction operation—which creates a clear distinction between the two operations and supports the step-by-step development of algorithms.
In some of the textbooks published by "Bit i Technika" [10], "Riva" [2] and "Archimedes" [7] these topics are not treated as separate lessons, indicating a different, integrated approach to structuring the curriculum content rather than a differentiated one.
In the textbooks published by "Prosveta Plus" [1], "Bulvest" [3], and "Anubis" [9], new knowledge is formed through mathematical visualisation based on the place-value principle. The methodology relies on an analytical-synthetic approach, in which numbers are viewed as composed of tens and ones. The presentation through tables of decimal composition, as well as the visualization through colored columns and squares in the textbook by "Prosveta Plus" [1] and through the grouping of colored sticks and coins in the textbooks by "Anubis" and "Bulvest" [3] creates a clear, concrete-visual understanding of the structure of numbers and the process of performing the operation itself, facilitating the transition

from concrete to abstract thinking. This approach helps students realize that operations are performed within the context of the given sequence, which is key to understanding algorithms without carrying.

In contrast, the textbook published by "Pythagoras" [6] uses a more limited and less developed visual model (using coins). The emphasis is on the type of problems that help students understand the correlation addition and subtraction: *if we subtract one addend from the sum of two numbers, we get the other.*

In the textbook published by "Scorpio" [8], the introduction is primarily implemented through story-based and text-based problems, which points toward a situational and contextual approach. Although this increases motivation and connects knowledge to students' real-world experiences, the lack of sufficient concrete visual aids during the initial introduction may hinder the comprehension of algorithms, especially for students with less developed abstract thinking.

To clarify **the second group** of cases, it is advisable to use a concrete, schematic, and mathematical model in sequence. The numbers are then arranged in a table with rows, thus forming algorithms of the specified type.

The cases in the second group are presented differently in the various teaching kits, both in terms of lesson structure and methodological approaches.

In the textbook published by "Prosveta Plus" [1] these cases are presented in a separate lesson, which allows a clear focus on the new type of operations and their comparison, as they are covered in the same lesson.

In the textbooks from the following publishers: "Prosveta" [4], "Pythagoras" [6], "Archimedes" [7] and "Riva" [2] the content is divided into separate lessons in addition and subtraction, which supports the step-by-step development of algorithms. This allows students to focus on the algorithms for the individual operations. In the textbooks published by "Anubis" [9], "Bit and Technika" [10] and "Bulvest" [3] cases from the different groups are combined into a single lesson, which implies a higher degree of generalization and saves instructional time, but at the same time places higher demands on students' cognitive readiness.

In the textbook published by "Scorpio" [8] the content is more integrated; new knowledge is not introduced through a clearly defined stage but is incorporated into a system of problems. This would make it difficult for students to discover the algorithm on their own and could lead to incomplete and superficial learning. Ultimately, the presentation of new knowledge is again based on the analytical-synthetic approach, which is implemented by breaking numbers down into tens and ones. This approach is particularly evident in the textbooks published by "Prosveta Plus" [1], "Anubis" [9], and "Archimedes" [7]. Through it, students realize that a two-digit number has an internal structure (for example, 24 = 2 tens + 4 ones), which allows operations to be performed separately in the order of the ones or tens. Thus, algorithms are constructed not mechanically, but as a consequence of understanding the decimal positional system.

Mathematical operations are presented as actions on objects or movement along the number line. This approach is characteristic of textbooks published by "Prosveta" [4], "Prosveta Plus" [1], and "Bit i Tekhnika" [10]. Through this approach, addition is perceived as "adding" or "moving forward," and subtraction as "taking away" or "moving backward." This facilitates the initial understanding of the operations and creates a connection to students' real-world experiences.

All of the textbooks listed, with the exception of those published by "Scorpio" [8] and "Pythagoras" [6], use an algorithmic approach in which the operations are presented as a sequence of steps —writing the numbers in rows in a number chart, performing the operations in the ones place, writing down the result, then performing the operations in the tens place, and writing down the result again. This approach helps develop accurate computational skills and prepares students for more complex algorithms. At the same time, the textbooks published by "Pythagoras" [6] and "Scorpio" [8] do not present the algorithm using a row table; only a version involving mental calculation is provided. This may hinder the development of precise algorithmic concepts.

When studying the cases from **the third group**, an appropriate visual aid can be used, after which the numbers are arranged in the row table, and finally, the algorithms for written addition and subtraction of numbers of the type under consideration are formulated.

In the textbooks published by "Prosveta Plus" [1], "Pythagoras" [6], "Bulvest" [3], "Archimedes" [7], and "Bit i Technika" [10], the cases under consideration are separated into independent or clearly differentiated sections, which facilitates the targeted introduction of the algorithm. In contrast, in the textbooks published by "Anubis" [9], "Riva" [2], "Scorpio" [8] and "Prosveta" [4] these cases are not presented as separate lessons but are included in a broader context, which may make it difficult to highlight their specific features—namely, that the operations are performed only in the tens place, while the ones remain unchanged.

Particular attention should be paid to the textbooks published by “Bulvest” [3], “Bit i Technika” [10] and “Prosveta Plus” [1], where new knowledge is introduced through highly concrete, object-based visual aids. Models of tens and ones (colored cubes, grouping, and breaking down numbers) are used to clearly demonstrate that in operations such as (27 + 10; 37 — 10), changes occur only in the tens place. This approach helps students build a solid understanding of the structure of numbers and grasp the algorithm through observation and action, rather than through rote memorization.

Here again, the primary methodological approach used in most textbooks is the analytical-synthetic approach, implemented by breaking numbers down into tens and ones:

- when adding a round ten, the number of tens increases;
- when subtracting a round ten, the number of tens is reduced;
- the ones remain unchanged.

In the textbook published by “Archimedes” [7] the new concept is presented through visual aids and examples, but it is noted that there is no clearly formulated algorithm for the case (35 — 20). Students arrive at the result through models and examples, but without an explicitly generalized rule. This may make it difficult for some students to apply the knowledge independently, as there is no clear illustration of the algorithm.

The textbook published by “Bit and Technika” [10] employs an inductive approach, in which new knowledge is introduced through concrete problems and situations. Through observation and working with models, students arrive at the method of calculation, but the algorithm is not presented separately; rather, it is presented alongside examples of adding and subtracting a two-digit number from a one-digit number without carrying.

In the textbooks published by “Pythagoras” [6] “Prosveta Plus” [1] and “Bulvest” [3] the exercises for reinforcing knowledge and skills are particularly diverse and include both basic and advanced cases, which aids in a more thorough mastery of the material. Only the “Bulvest” [3] textbook lacks word problems.

The reasoning behind studying the problems in **the fourth group** is as follows: initially, the numbers are modeled using concrete models, then schematic models are used, and finally, the numbers are arranged in the rows of the table, with algorithms for written addition and subtraction of numbers of the type under consideration being formulated.

The introduction of new knowledge most often begins with a real-life word problem that creates a problem situation. For example, in textbooks published by “Anubis” [9] and “Archimedes” [7], students encounter real-life situations (money, objects) that require performing the arithmetic operations of addition or subtraction. This is followed by presenting the solution by breaking down the numbers into tens and ones and recording them in a table across the rows.

In the analyzed textbooks, visual aids vary in degree and type; in the textbooks published by “Prosveta Plus” [1] and “Bulvest” [3] a rich variety of concrete and visual aids is observed–colored blocks, tokens, coins, and other models are used to illustrate tens and ones. This is important for the transition from concrete to abstract thinking. The textbook from the “Bit i Technika” [10] publishing house also uses a variety of visual aids.

In the textbooks published by “Anubis” [9] and “Prosveta” [4] the visual aids are more structured and are primarily implemented through a number chart (tens and ones). This serves as a means of presenting the algorithms for the operations and clearly shows the order in which the operations are performed.

In the textbooks published by “Pythagoras” [6] and “Riva” [2] the visual presentation is more schematic–through the decomposition of numbers and the use of arrows and diagrams, which encourages the development of thinking strategies.

In the textbook published by “Scorpio” [8], visual aids are more limited and consist mainly of the use of an abacus and a table, which is not always sufficient for all students.

In terms of algorithmic approach, no significant differences are observed. In all textbooks, the algorithm is clearly formulated using number tables and the order of operations (“add the ones, add the tens,” “first subtract the ones, then the tens”), which aids in mastering the standard method of calculation. Only in the textbook published by “Bulvest” [3] is the algorithm formulated based on mental calculation methods, specifically breaking down the addends into sums of tens and ones and adding them sequentially in rows: 32 + 26 = (30 + 20) + (2 + 6) = 50 + 8 = 58.

Representing one addend as the sum of its tens and ones and adding them sequentially to the other: 32 + 26 = (32 + 20) + 6 = 52 + 6 = 58 or 32 + 26 = (32 + 6) + 20 = 38 + 20 = 58. This can lead to students learning the process mechanically without sufficient understanding. The algorithms for mental calculation are also covered by the other author teams, but not all of them include them in the lesson introducing the new concept.

The types of consolidation problems also show variety. All textbooks include arithmetic problems for

direct calculation. In addition, word problems are widely used to develop mathematical modeling skills. The textbooks from the publishers “Pythagoras” [6] “Riva” [2] and “Prosveta Plus” [1] also include more challenging problems–composing word problems, finding an unknown number, and verifying equalities and inequalities. The textbook published by “Prosveta” [4] includes problems with number lines and visual models that aid in understanding the relationship between addition and subtraction. In the textbook published by “Riva” [2], problems involving relations (comparisons and filling in tables) play a special role in developing logical thinking.
To reinforce new knowledge, a diverse system of problems is used:

- calculation problems for automation;
- table-filling problems;
- practical word problems;
- problems for identifying relationships;
- combined problems requiring deeper thinking.

3. Conclusion

An analysis of the nine second-grade mathematics curriculum sets approved by the Ministry of Education and Science (MES) shows that they offer a structured and multifaceted approach to learning, particularly regarding addition and subtraction of numbers up to 100 without carrying. The variety of methods, examples, and visual aids facilitates students’ understanding of the material and stimulates the development of their analytical and research skills. It can be concluded that the most effective way to clarify the algorithms for addition and subtraction without crossing the tens place is to combine several approaches:

- concrete visual aids → for initial understanding
- breaking down into tens and ones → to grasp the structure
- algorithmic steps → for skill development
- exercises and problems → for reinforcement.

To summarize, all textbooks cover addition and subtraction of two-digit numbers without carrying, but they differ in their method of introduction, the degree of visual representation, and the variety of problems. The most effective mastery of the cases covered is achieved by combining visual aids, an analytical-synthetic approach, and a clearly formulated algorithm. Of particular importance is the use of concrete models, which aid students’ understanding of the material and facilitate the transition from concreteness to abstraction. The differences, in turn, reflect various didactic approaches and can be effectively utilized in practice by combining their advantages. Since every student learns differently, the materials must meet diverse needs—ranging from strong object-based visual aids for some to more abstract schematic models for others.
Educational standards are changing to align with European requirements, so teaching materials must be constantly updated and strive for innovations that enrich the learning process and make it even more effective and accessible to all students.

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Creating Digital Learning Resources Using Scratch for Learning 4th Grade Mathematics

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Abstract

The article is dedicated to the creation and use of digital resources created on Scratch when teaching mathematics in the fourth grade. An animated Scratch module from the educational content of the mathematics textbook with authors Prof. Dr. Vladimira Angelova and Zhana Koleva, Prosveta Plus Publishing House, Sofia, 2019 is described in detail. Presented in this way, it offers an opportunity to integrate information technologies into mathematics classes in order to better master the educational material.

The purpose of the publication is to present the proposed methodological tools for the application of information technologies in mathematics teaching in the fourth grade, namely - animated Scratch modules, based on the educational content, would help to more effectively master knowledge, skills and attitudes related to mathematical literacy and modern key competencies of students. This would lead to a more effective implementation of the learning goals, to increasing students' interest in mathematics as an academic discipline and building a positive emotional attitude towards it. The expectations are also to create a better transition to the future professional and life realization of the students. The specifics of the developed learning content, the electronic environment, the animated scenarios and the teaching method are related to the 9 key competencies for the development of students set out in the curriculum and program, but the main emphasis is on "Mathematical Competence" and "Digital Competence".

Keywords: *Scratch, mathematics, information technology, digital resources, educational content*

1. Introduction

The dynamics of the last few years and the changes that have occurred in the life of the planet, dictated by global crises that have an impact in various areas - health, social, economic, political, etc., have imposed new requirements on education, namely that the environment be more flexible, open, social, healthy, interactive and digital. It is of key importance to implement various innovations in the educational process in a timely manner, to make modifications in the training trajectories that are adapted to the pace of learning and skills by learners. The UNESCO Global Education Monitoring Report for 2023, which focuses on technology and education, explicitly emphasizes that the opportunities and challenges posed by technology are the main construct for achieving quality education and sustainable development. In more and more areas of life, societies are moving towards digitalization, or in other words, this is the structuring of social life around digital communication and media infrastructure. Digital literacy should “respond to the current and future needs of learners and the community” and “provide students with the tools they need to address contemporary challenges” [7]. The increasing use and presence of digital solutions in people’s daily lives creates a need for systemic change based on digital transformation as a whole. It is important to note that *technologies and Media are effective tools when used as intended* . When we talk about digital learning, we mean any type of learning that is supported by technology or through pedagogical practices and techniques that make the use of a given technology effective.

The integration of digital educational tools into the learning process is inevitable, especially in subjects that usually have difficulty going hand in hand with imagination and fun. It is extremely difficult for students to connect reality with mathematical concepts. This problem is clearly highlighted in the results of the PISA tests - nearly 45% of Bulgarian children are able to cope with only the most elementary tasks [8] .

Primary school students perceive knowledge more effectively in an interactive environment. That is why the use of block-based programming, as an environment for creating visual models and interactive tasks, is emerging as a promising approach in mathematics education. It allows for the combination of logical thinking, creativity and practical application of mathematical knowledge. In this way, one of the most

favorite teaching methods of students is applied, namely - gamification ("use of game elements in a non-game context") [4] , which not only attracts attention for a longer time, but also increases the motivation and self-confidence of students.

2. Designing a Prototype of an Educational Animated Module in "Mathematics " for Fourth Grade

2.1 Pedagogical Characteristics of an Animated Module "Geometric Friends". Scenario and Technological Implementation

The created game "Geometric Friends" is from the educational content of the topic "Geometric Figures" on page 11 of the textbook "Mathematics" for 4th grade, authors V. Angelova, Zh. Atanasova of the publishing house Prosveta Plus [1] . The game is aimed at systematizing and summarizing the knowledge and skills of students about the studied geometric figures. With the help of the task, students will consolidate their competencies:

- Recognizes geometric shapes: square and triangle;
- Recognizes the types of triangles according to their sides;
- Defines a square as a type of rectangle;
- Defines a square as a rectangle;
- Solves geometric problems.

The proposed module includes a text problem that illustrates a square and an equilateral triangle. In the problem, we know the perimeter of the square and how much longer its side is than the side of an equilateral triangle. We are looking for the perimeter of the triangle in centimeters. Students consolidate their knowledge of geometric figures - a square and an isosceles triangle - by making the connection between the four sides of the square, and then use the condition and the data in it to be able to find the perimeter. When they find the side of the square, they can find the side of the triangle, and from there its perimeter.

The plot of the module is developed in three scenes, two of which are repetitive, but in each subsequent scene there is a different animation. The whole game proceeds sequentially step by step in accordance with the educational content. In order for the student to move forward in his solutions, he must successfully solve, record and calculate the problems, which consist of three numerical expressions.

The game is intended for all fourth grade students, and since they do not experience any difficulty in reading, the module is made like a comic book in which the students can read the characters' lines themselves. Although some of the students read more slowly and others faster, the time for reading the speech is sufficient and tailored to the needs of all fourth graders.

The characters in the game always give a positive assessment in support of the student, noting his knowledge, and for each correct answer he receives praise, this is key to achieving a pleasant atmosphere for the student, and at the same time maintaining his interest in the game. When the student makes a mistake, he is instructed to correct his mistake with an indefinite number of attempts. The game is dynamic and interactive for students.

In the first scene, students are introduced to a character named Annie, who is selected from the library available in “Scratch”, and she is in a “school corridor” decor, which was selected specifically for the game itself. This is an introductory scene before the game begins, so the character only welcomes the student and tells him that it is time to review the geometric shapes studied (square and triangle). Annie goes to the classroom to introduce the student to an old acquaintance from math class. (Fig. 1)

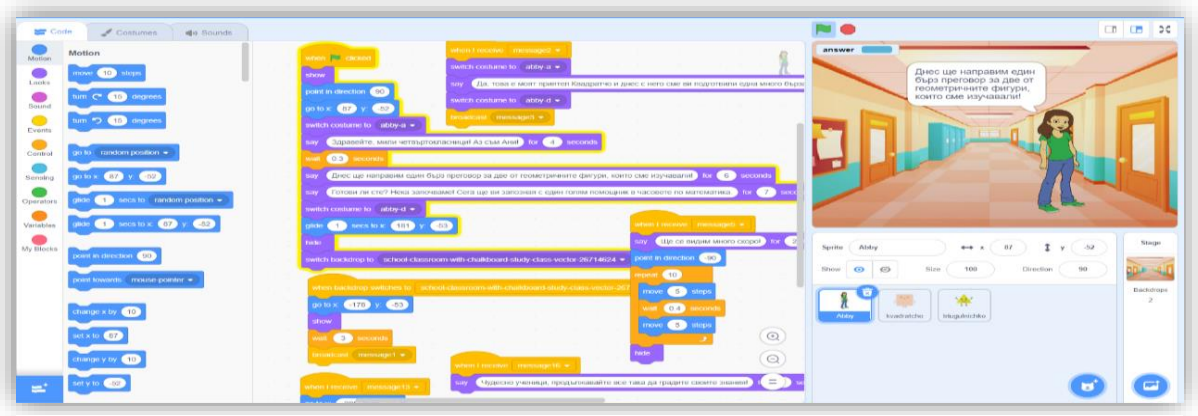


Fig. 1. Module "Geometric Friends", Scene 1.

The next scene is in a “math classroom” setting, which was again specially selected for the task. After Annie entered the room, she introduced the student to her old acquaintance from math classes, the square “Square”. Before introducing herself, the square wants to have a talk by asking the student what geometric figure she is. After the student answers the question, “Square” introduces the student to his assistant “Triangle”, when the triangle appears in the scene he does not forget to ask the student what geometric figure she is, after answering correctly, the heroine Annie leaves and the game begins. Both characters are not available in “Scratch”, but are specially selected for the content of the game. The goal in this part of the game is to consolidate the student’s knowledge of the geometric figures square and triangle. (Fig. 2)

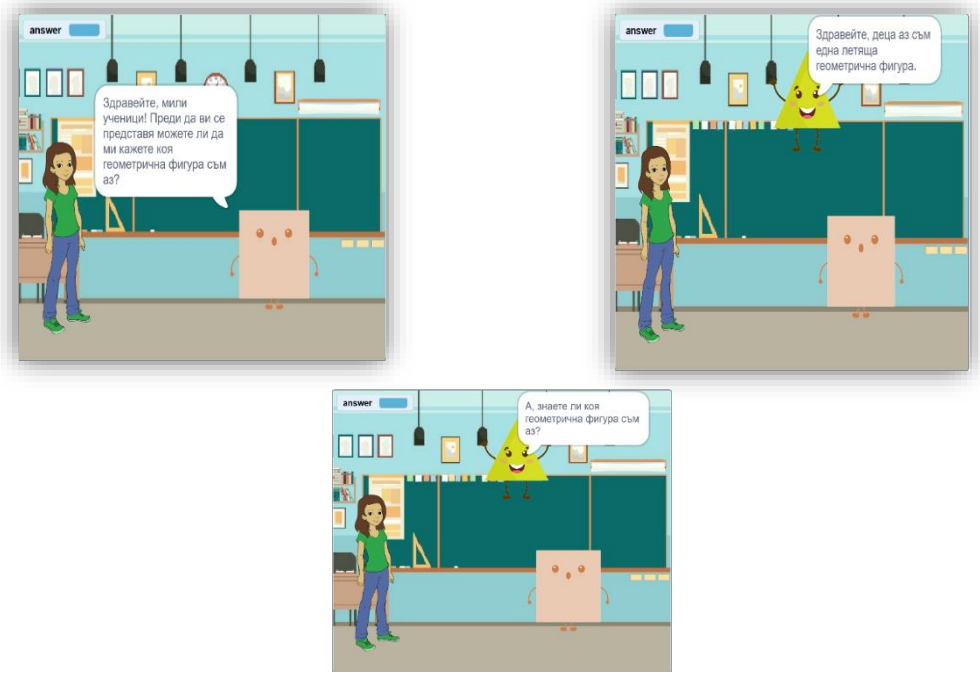


Fig. 2. Module "Geometric Friends", Scene 2.

When the game begins, the decor remains unchanged. The two characters state the condition of the task, they take turns, giving the student an instruction in advance to read carefully. To make the game more interesting for the student, the condition is a little more broken down, instead of “The perimeter of the square is …” the character says: “My perimeter is …” (Fig. 3). The goal of this part of the game is for the student to consolidate his ability to solve a geometric problem and to compose and calculate numerical expressions to solve the specific task. After they finish stating the condition of the task, the character “Square” checks whether the student has been paying attention, by asking him what is known from the condition and what is being sought. The student has time in which to answer these two questions orally. This is followed by a question in which the student must again verbally state what type of triangle is in the problem, thereby consolidating his knowledge and skills in recognizing the types of triangles according to their side (Fig. 4). When the student answers this question correctly, the problem is solved. Together with the help of the square and the triangle, the student must be able to write down and solve the three numerical expressions. With the help of the "Triangle", the fourth-grader must be able to find the side of the square by dividing the perimeter by the number of sides of the square. After finding the side of the square with the help of the "Square", he must be able to find the side of the triangle, using the information available about the side of the triangle from the condition. When he is completely ready with these solutions with the help of the "Triangle", the student will also be able to find the perimeter of the triangle.

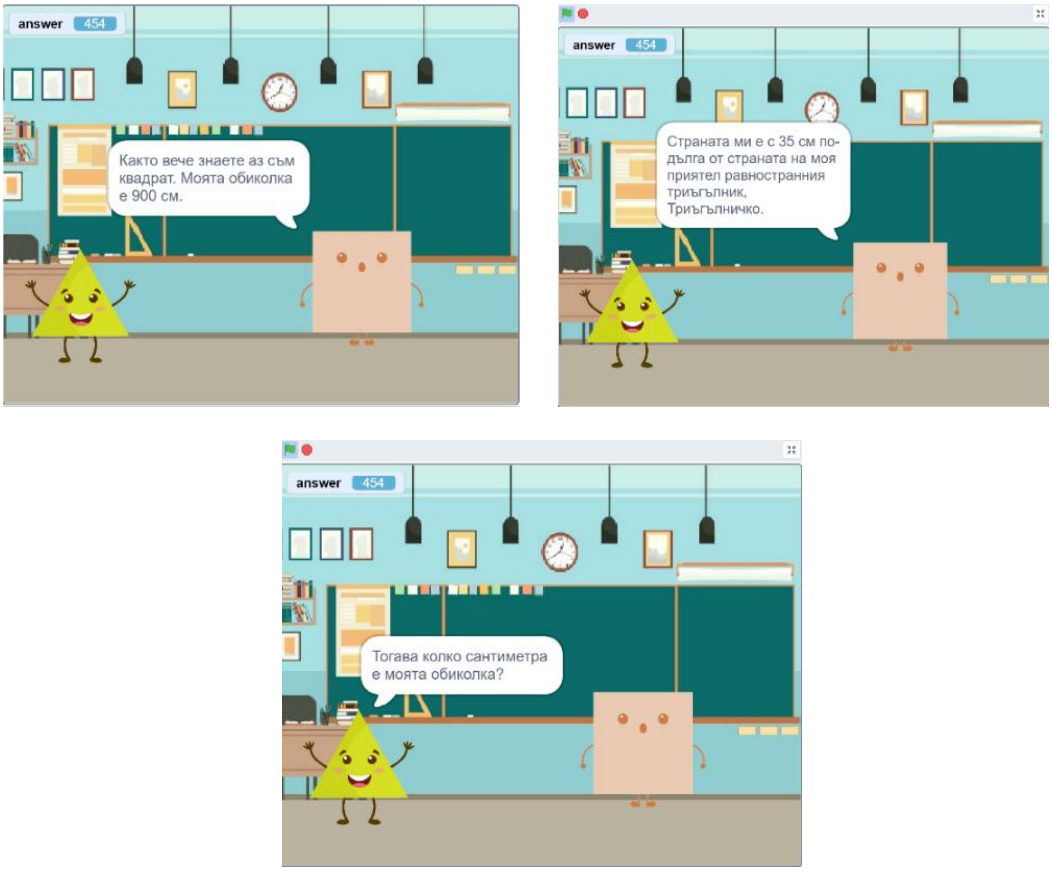


Fig. 3. Module "Geometric Friends", Scene 2.

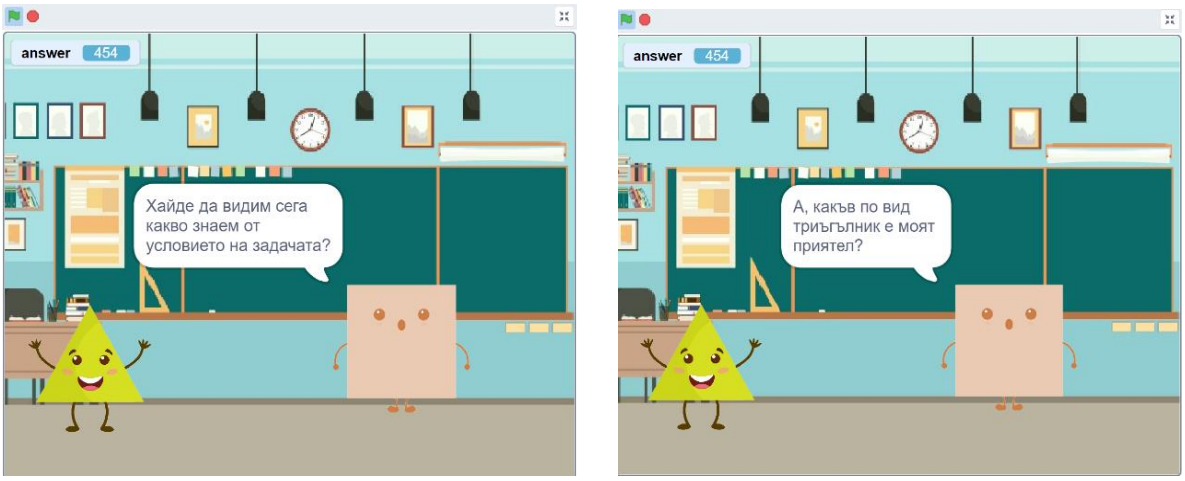


Fig. 4. Module "Geometric Friends", Scene 2.

Each numerical expression and its solution should be written in the field indicated for this with a blinking cursor, and the time for writing the solution is unlimited. After the student writes his answer, he should confirm the command by clicking on the blue tick with the mouse or pressing the “enter” button on the keyboard. When the student’s answer is correct, he receives praise from the geors “Great!”, and when the answer is wrong, he is given the opportunity to try again to solve the expression – “Try again!”, and this opportunity for correction is unlimited. (Fig. 5)

Only when the student has solved the entire geometric problem does the final scene follow, in which the

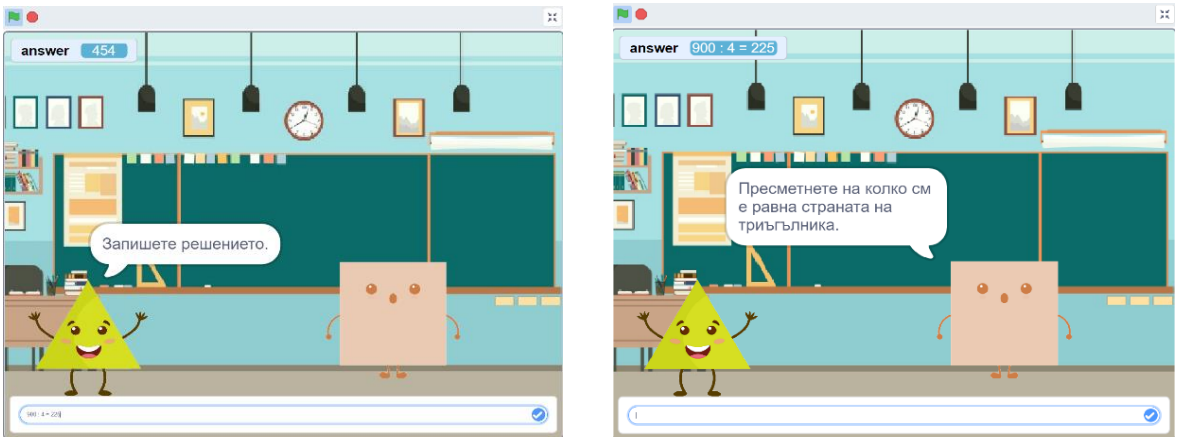


Fig. 5. Module "Geometric Friends", Scene 2.

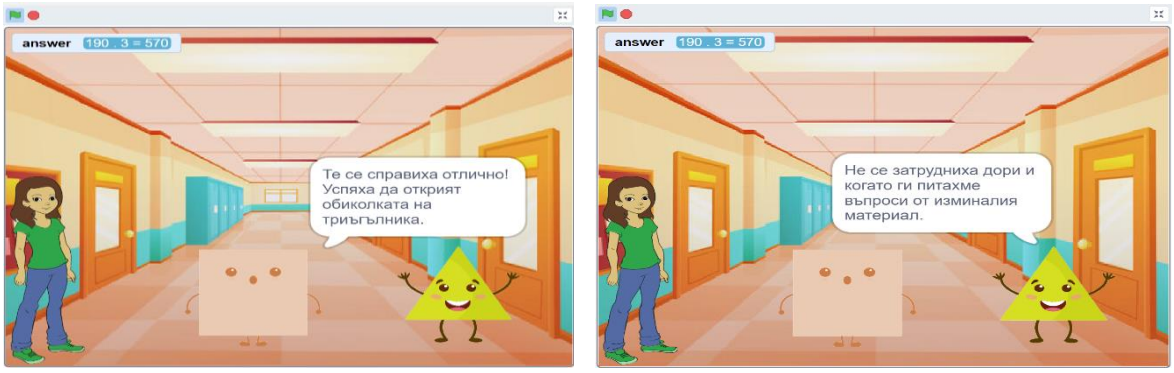


Fig. 6. Module "Geometric Friends", Scene 2.

decor changes again to a "school corridor", where Annie waits for the other two characters to give an assessment of how the student coped with solving the problem, of course the assessment is positive. (Fig. 6)

The game is suitable for both review and practice classes, as well as for individual preparation for each student.

3. Results

The pedagogical experiment was conducted in a class with 24 students. The class was divided into two groups of 12 students. The experimental group solved the task in Scratch within the framework of a lesson, while the control group worked with traditional exercises from the "Prosveta Plus" textbook. In the experimental group, the success rate in integrating Scratch was 89%, without violating the logic of the educational content in compared to 67% in the control group. These data show that creating and implementing digital electronic resources using Scratch facilitates the consolidation of learning content in mathematics classes. After completing this task, students in the experimental group were much more motivated and engaged with the remaining tasks during the lesson, while students in the control group did not change their motivation in any way, which confirms the role of visualization in increasing engagement. At the end of the class, a test was given to the class with the same task from the textbook, and students who had solved the task earlier with Scratch had 93% excellent results, while the group that solved the task in the textbook had an average result of 75% correct answers, which confirms the effect of visualization on the acquisition of skills.

4. Conclusion

The use of block-based programming in Scratch and the continuous enrichment of the methodological palette of 4th grade mathematics teachers is key to increasing student engagement and their motivation to learn. Digital educational tools will never stop developing, and to overcome the deficits in learning "Geometric Figures", the teacher must turn Scratch into his ally.

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Study of the Operation of Dividing Natural Numbers by a One-Digit Number: Analysis of the Current State in Mathematics Textbook Sets for Grade 4

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Abstract

The most recent reform in primary mathematics education in Bulgaria, implemented in 2017, initiated substantial changes in the curricula and led to the approval of seven new textbook sets for the primary stage. The present paper is devoted to a comprehensive theoretical and practical analysis of the methodology for teaching division of multi-digit numbers by a one-digit number in Grade 4. This topic is of critical importance for the development of mathematical literacy and logical thinking among primary school pupils.

The study identifies and substantiates eight key methodological cases arranged in a strict logical sequence according to their cognitive complexity. The system begins with oral division of numbers expressed in place-value units and proceeds through algorithms without regrouping, cases with one or more regroupings in adjacent and non-adjacent place values, and specific difficulties related to zero in the quotient and cases in which the leading digit of the dividend is smaller than the divisor.

A central focus of the research is the comparative analysis of the current textbook sets published by "Arhimed," "Riva," "Prosveta Plus," "Bulvest 2000," "Anubis," "Prosveta," and "Bit i Tekhnika." The paper examines how each author team implements the proposed sequence and where methodological differences or unjustified jumps in difficulty are observed. The results show varying degrees of correspondence with the logical progression of the material, which directly affects the quality of students' acquisition of written algorithms. The paper offers valuable guidance for primary school teachers and methodologists, emphasizing the need for a systematic approach to teaching arithmetic operations in Grade 4.

Keywords: *mathematics education; division of natural numbers; Grade 4; textbook analysis; primary school*

Introduction

In recent years, educational reform in Bulgaria has been primarily directed toward the alignment of national educational standards with European Union standards. In this process, curricula have become a fundamental instrument for defining instructional aims, content, and expected learning outcomes for a given subject within a particular grade. The main objective of this process is to ensure that pupils receive high-quality education that is both appropriate and competitive in an international context.

Each topic in the curriculum is associated with specific expected outcomes and key concepts from different competence areas, with emphasis placed on the acquisition of arithmetic skills. These outcomes include knowledge aligned with the subject matter as well as with the age and cognitive capabilities of pupils. The methodological guidelines embedded in the mathematics curriculum for Grade 4 emphasise the use of technologies and strategies for mastering arithmetic operations such as multiplication and division of multi-digit numbers by one-digit numbers. This underscores the need to create an adaptive learning environment resposive to pupils' individual needs.

1. Method

The aim of this paper is to present the theoretical propositions that form the basis of the methodology for studying the topic "Division of a Multi-Digit Number by a One-Digit Number" and its implementation in the currently available mathematics textbook sets for Grade 4 of primary education.

Division of a multi-digit number by a one-digit number is taught through algorithms for written computation and through methods of oral computation.

A specific feature of division is that, in both oral and written procedures, calculations always begin from the highest place value of the dividend.

Written division is carried out in strict accordance with the following algorithm: activation of prior knowledge and skills concerning the meaning of division; the algorithm for dividing numbers up to 1000 by a one-digit number; the distributive property of division with respect to addition; and the ability to represent multi-digit numbers as sums of their place-value units in different ways.
The cases of division of numbers greater than 1000 by a one-digit number are grouped into two main categories:
Division without regrouping, in which each place value of the dividend is divided exactly by the divisor; and division with regrouping, in which at least one place value requires transformation.
The algorithms for computation should be studied in a specific sequence. The study of the algorithms for written and oral division of a multi-digit number by a one-digit number is organised in the following logical progression:

1. Division of numbers of the type 6000 : 2; 6,000,000 : 2 and 1500 : 3; 15,000 : 3; 15,000,000 : 3
2. Division of a multi-digit number by a one-digit number without regrouping, for example 4682 : 2
3. Division of a multi-digit number by a one-digit number with one regrouping, for example 3268 :
4. Division of a multi-digit number by a one-digit number with more than one regrouping in non-adjacent place values, for example 3674 : 2.
5. Division of a multi-digit number by a one-digit number with more than one regrouping in adjacent place values, for example 4386 : 3.
6. Division of a multi-digit number by a one-digit number when one of the digits in the quotient is zero, for example 6128 : 2.
7. Division of a multi-digit number by a one-digit number when more than one digit in the quotient is zero, for example 61,524 : 3.
8. Division of a multi-digit number by a one-digit number when the number of units in the highest place value of the dividend is less than the divisor, for example 1926 : 3.

This approach to arranging and studying the cases of division by a one-digit number is logically justified. It systematically derives all computational algorithms and organises them according to their complexity. The first of the listed cases is based on the decimal structure of the multi-digit number, with oral methods of division being applied. In deriving the algorithms for the subsequent cases, the distributive property of division with respect to addition is applied.
In order for pupils to recognize the practical necessity of mastering the algorithms for finding the quotients of multi-digit numbers by a one-digit number, it is appropriate to use a word problem as an introductory task, the solution of which requires the application and clarification of the new algorithm.

2. Analysis of Individual Cases

First Case: Division of Numbers of the Type 6000 : 2; 6,000,000 : 2; 1500 : 3; 15,000 : 3; 15,000,000 : 3

In deriving oral methods for division of numbers of the type 6000 : 2 and 6,000,000 : 2, the following conversions are used:
number ↔ number of thousands, for example 6000 = 6 thousand, 3 thousand = 3000;
number ↔ number of millions, for example 6,000,000 = 6 million, 3 million = 3,000,000.
The computation is reduced to basic multiplication facts.
For example:
6000 : 2 = 6 thousand : 2 = 3 thousand = 3000;
6,000,000 : 2 = 6 million : 2 = 3 million = 3,000,000.
The quotients of the type 1500 : 3; 15,000 : 3; 15,000,000 : 3 are clarified through analogous transformations, together with multiplication facts.

2.1 Second Case: Division of a Multi-digit Number by a One-digit Number without Regrouping (for Example 4682 : 2)

An analysis of the approved mathematics textbook sets for Grade 4 shows diverse approaches to teaching the division of a multi-digit number by a one-digit number without regrouping, for example 4682 : 2.
The methodology for introducing this case is as follows:
the dividend is represented as a sum of its place-value units, and the distributive property of division with respect to addition is applied:

4682 : 2 = (4 thousands + 6 hundreds + 8 tens + 2 units) : 2
= 2 thousands + 3 hundreds + 4 tens + 1 unit = 2341.
The written algorithm is explained with the help of a place-value table in which the dividend is recorded, emphasising its decimal structure. The division sign and the one-digit divisor are written to the right of the table. It is emphasized that division begins with the highest place value, in this case the thousands.

Thousands	Hundreds	Tens	Units
4	6	8	2
2	3	4	1

: 2

Written as:

4682 : 2 = 2341

The written algorithm for division of numbers of this type (4682 : 2) is as follows:

1. Divide the thousands of the dividend by 2. We obtain 4 thousands : 2 = 2 thousands. Write 2 thousands in the result.
2. Divide the hundreds of the dividend by 2. We obtain 6 hundreds : 2 = 3 hundreds. Write 3 hundreds in the result.
3. Divide the tens of the dividend by 2. We obtain 8 tens : 2 = 4 tens. Write 4 tens in the result.
4. Divide the units of the dividend by 2. We obtain 2 units : 2 = 1 unit. Write 1 unit in the result.

We obtain 2 thousands + 3 hundreds + 4 tens + 1 unit = 2341.
Finally, the procedure is presented without the table.
In my view, the methods for dividing a multi-digit number by a one-digit number without regrouping can be summarized as follows:

First method:

4682 : 2

= (4000 + 600 + 80 + 2) : 2

Second

4682 : 2 = 2341

In the first method, the dividend is represented as a sum of its place-value units, and the distributive property of division with respect to addition is applied.
In the second method, the written computation algorithm is applied.
Such cases are presented in all seven approved textbook sets for compulsory mathematics instruction in Grade 4: the set published by “Arhimed,” by R. Alashka and colleagues [1]; by “Riva,” by L. Aleksieva and M. Kirilova [2]; by “Prosveta Plus,” by V. Angelova and Zh. Koleva [4]; by “Bulvest 2000,” by M. Bogdanova, M. Temnikova, and V. Ivanova [5]; by “Anubis,” by T. Vitanov and colleagues [9]; by “Prosveta,” by Yu. Garcheva and A. Manova [6]; and by “Bit i Tekhnika,” by D. Kapitanova and colleagues [7].
In the textbook by V. Angelova and Zh. Koleva [3] the oral method of computation is first clarified, with the dividend represented as a sum of its place-value units and the distributive property applied; for the written method, a place-value table is used, and a clearly formulated algorithm for carrying out division is presented.
In the textbooks by L. Aleksieva and M. Kirilova and by D. Kapitanova and colleagues [7], a place-value table is used to explain the algorithm for performing division, but the algorithm is not explicitly formulated. The oral method of computation is insufficiently elaborated.
In the textbook by M. Bogdanova and colleagues [5], both an oral computation algorithm and a written computation algorithm are included. No tabular form is used.
The authors of the Grade 4 mathematics textbook, L. Vitanov and colleagues [9], first explain the oral method of computation; for the written method, they use a place-value table, but no clearly defined algorithm for written computation is provided.
In the Grade 4 mathematics textbook by Yu. Garcheva and A. Manova [6], no algorithm is formulated for the written division of a multi-digit number by a one-digit number; instead, pupils are directed to apply the corresponding algorithm for division with numbers up to 1000.

2.2 Third Case: Division of a Multi-digit Number by a One-digit Number with One Regrouping (for Example 3268 : 2)

In the third case, division in one of the place values is results in a remainder, which is carried to the next place value. The methodology for introducing this case is analogous to that described in section 2.2. It is important that pupils understand the role of the remainder and its relation to the decimal structure of the number, rather than perceiving regrouping as a purely formal operation.
In the textbook by "Arhimed," these tasks follow immediately after the cases without regrouping; an oral method is demonstrated through decomposition of the dividend and the carrying of the remainder, after which the standard written algorithm is shown. In the textbook by "Riva," cases with one regrouping are also included, but the emphasis is mainly on written division by example, with more limited oral explanations of the written algorithm.
In the textbook by "Prosveta Plus," the methodology is developed in greater detail: an oral method is first presented, and then the written algorithm is introduced with the corresponding steps and comments in a place-value table. In the textbook by "Bulvest 2000," both oral and written methods are presented, but greater emphasis is placed on the standard vertical layout. In the textbook by "Anubis," a place-value table is used, but a clearly formulated step-by-step algorithm is not provided, while in the textbook by "Prosveta," reliance is placed on transferring knowledge of division of numbers up to 1000 by a one-digit number. The textbook by "Bit i Tekhnika" includes a variety of tasks with one regrouping, but the algorithm is again presented mainly through solved examples.

2.3 Fourth Case: Division with More than One Regrouping in Non-adjacent Place Values (for Example 3674 : 2)

The fourth case involves divisions in which more than one remainder appears in different, non-adjacent place values, requiring pupils to follow a longer sequence of regroupings. The methodology for introducing this case is analogous to that described in section 2.2.
In the textbook by "Arhimed," such tasks appear after sufficient practice with simpler cases and are often marked as more difficult or included in sections intended for independent work.
In the textbook by "Prosveta Plus," these cases are introduced gradually, with visual support through a place-value table used purposefully to illustrate the carrying of remainders.
In the textbooks by "Riva," "Anubis," "Prosveta," and "Bit i Tekhnika," similar tasks are included, but they are not always clearly distinguished as a new type of difficulty; they are often distributed among general exercises without specific methodological commentary, which makes it more difficult for pupils to recognise the qualitatively new level of complexity.

2.4 Fifth Case: Division with More than One Regrouping in Adjacent Place Values (for Example 4386 : 3)

The fifth case is even more cognitively demanding, as remainders arise consecutively in adjacent place values and pupils must manage several successive regroupings without losing the logic of the algorithm. As in the previous cases, the methodology for introducing this case is analogous to that described in section 2.2.
The textbook by "Prosveta Plus" presents methodological guidance for such tasks through detailed solutions and intermediate questions that direct pupils' attention to each individual regrouping step.
In the textbook by "Bulvest 2000," tasks involving successive regroupings are also included, along with diagnostic exercises that allow for assessment of pupils' understanding.
In other textbook sets, such cases appear more rarely and are often not explicitly distinguished from cases with one regrouping, which may lead to a more mechanical application of the algorithm.

2.5 Sixth Case: Division of a Multi-digit Number by a One-digit Number When One Digit in the Quotient is Zero (for Example 6128 : 2)

The sixth case encompasses divisions in which one of the digits in the quotient is zero. It is methodologically important because pupils often omit the zero in the quotinent or fail to understand that it is a significant digit in the positional number system. The methodology for introducing this case is analogous to that described in section 2.2.
In the textbooks by "Riva" and "Bulvest 2000," specially selected tasks are included in which the quotient contains a zero, and the explanations emphasise the necessity of writing the zero in the correct place

in the quotient. In the textbook by “Prosveta Plus,” guiding questions are also used (“How many tens do we obtain? If there are no tens, what do we write in the quotient?”), which help pupils understand the role of zero.
In the textbooks by “Anubis,” “Prosveta,” and “Bit i Tekhnika,” tasks with a zero in the quotient are included in the general set of exercises, but without specific methodological separation or additional oral or written explanations, which increases the likelihood of errors.

2.6 Seventh Case: Division of a Multi-digit Number by a One-digit Number When More than One Digit in the Quotient is Zero (for Example 61,524 : 3)

The seventh case involves division situations in which more than one digit in the quotient is zero, which places increased demands on pupils’ attention and on their understanding of sequences of zeros in the quotient. Such tasks are encountered relatively rarely and more often found in sections for consolidation or supplementary practice. The methodology for this case is analogous to that described in section 2.2.
In most textbook sets, with the exception of isolated examples in “Prosveta Plus” and “Bulvest 2000,” there is no targeted work aimed at helping pupils understand a sequence of zeros in the quotient, which leaves this case partially embedded within the general flow of exercises.

2.7 Eighth Case: Division of a Multi-digit Number by a One-digit Number When the Number of Units in the Highest Place Value of the Dividend is Less than the Divisor (for Example 1926 : 3)

The eighth case is conceptually challenging, as it requires pupils to realise that they cannot divide the leading digit of the dividend alone, but must take the first two digits together, which changes the position of the first digit in the quotient. The methodology for introducing this case is analogous to that described in section 2.2.
In the textbooks by “Arhimed,” “Prosveta Plus,” and “Bulvest 2000,” such tasks are introduced after secure mastery of the other cases, accompanied by oral explanations and visual examples showing why the first digit cannot be divided separately and how this affects the place of the quotient.
In the textbooks by “Riva,” “Anubis,” “Prosveta,” and “Bit i Tekhnika,” similar tasks appear earlier in the sequence and without sufficient methodological emphasis, which increases the likelihood of errors and a more mechanical application of the procedure.
Conclusions and Methodological Recommendations
Summarising the analysis across the eight cases, the following conclusions can be drawn:
The proposed system of eight cases fully encompasses the range of division situations involving multi-digit numbers by a one-digit number within the primary curriculumand may serve as a criterion for evaluating the completeness and methodological soundness of textbook sets.
Although all textbooks formally comply with the curriculum, there are substantial differences in how consistently they follow the logical progression of the cases and in the way they emphasise difficult situations.
The most effective textbook sets are those that combine oral methods, visual support, and clearly formulated algorithms, and that provide a sufficient number of tasks involving more than one regrouping and zero/s in the quotient.
From a methodological perspective, the following recommendations are proposed:
The logical sequence of the eight cases should be strictly observed.
Oral and written methods should be systematically combined, with oral computation serving as a basis for understanding the written algorithm.
Special attention should be given to difficult cases such as multiple regrouping, zero/s in the quotient, and situations in which the leading digit of the dividend is less than the divisor.
Tasks with a practical orientation should be selected, in which division has real-life meaning, in accordance with the competence-based approach in education.
The role of the teacher is crucial: when deficiencies are identified in a particular textbook, the teacher should compensate through additional exercises, visual aids, and explanations, so as to ensure systematic and conscious mastery of division in Grade 4.

3. Conclusion

The study of division of multi-digit numbers by a one-digit number in Grade 4 plays a key role in developing stable arithmetic skills and in preparing pupils for more complex mathematical concepts in lower secondary education. Systematising the content through eight clearly distinguished

methodological cases ensures logical progression and enables more precise instructional planning at the primary level.
The analysis of the approved textbook sets shows that, although all of them meet the curricular requirements, there are substantial differences in the way algorithms are presented, in the degree of visual support, and in the emphasis placed on difficult cases related to regrouping and zeros in the quotient. This finding requires teachers to adopt a critical and reflective approach to the chosen textbook and, when necessary, to compensate for missing elements through additional tasks, oral methods, and visual models.
The proposed logical system of eight cases can serve not only as a tool for analysing existing textbook sets, but also as a guide for developing new teaching materials, supplementary aids, and methodological resources for primary mathematics education. In this sense, the results of the study are relevant both to classroom practice and to future research in the methodology of mathematics teaching.

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Can Young Children Learn Bioethics and Geoethics? Evidence from a Mediated Non-Formal Science Experience

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Abstract

This study explores the educational potential of introducing bioethical and geoethical issues to young children through mediated non-formal science education experiences. The research focuses on primary students (ages 6–12; n = 24) as audiences and interlocutors rather than direct participants in structured instructional interventions. The context involved an intergenerational science theatre project, in which adolescents created and performed a play addressing ethical dilemmas related to life sciences and human–Earth interactions. Following the performance, younger children participated in a brief ludic activity using emoji-based response cards and engaged in semi-structured group interviews. Additional interviews with institutional educators provided complementary perspectives on engagement, comprehension and pedagogical feasibility. Data were analysed qualitatively and through descriptive quantitative analysis of responses to ten statements addressing bioethical, geoethical and combined ethical themes. Results from the ludic activity indicate a high proportion of correct responses in bioethical topics (95.8%), alongside consistent levels of correct responses in geoethical (80.2%) and mixed bioethical–geoethical categories (81.2%). These patterns suggest that children were able to recognise ethical dimensions, differentiate between types of socioscientific issues and articulate positions aligned with the narratives presented. Interview data further revealed emotional engagement, concern for living beings and the environment, and the ability to relate ethical questions to everyday experiences. Overall, the findings indicate that mediated, narrative-based and intergenerational approaches can lower conceptual barriers and support inclusive engagement with complex ethical dimensions of science in primary education. The study contributes to science education by highlighting non-formal, narrative-based approaches as effective entry points for early ethics learning, and by proposing mediated ethical understanding as a framework to explain how young learners engage with ethical dimensions of science.

Keywords: *Primary education; Bioethics; Geoethics; Socioscientific issues; Non-formal education*

1. Introduction

The increasing relevance of socioscientific issues (SSI), particularly those related to sustainability, technological development, and human-Earth system interactions, has reinforced the need to reorganise science education to integrate scientific understanding, ethical reflection, and responsible citizenship [1]. However, ethical dimensions remain underrepresented in formal science education [1,2], particularly in the early years, often due to assumptions about children's cognitive readiness to engage with abstract ethical concepts and the complexity of ethical deliberation required in socioscientific contexts [3,4].

Traditional approaches to science education tend to privilege conceptual knowledge over ethical deliberation, frequently relying on transmissive pedagogies that limit student engagement and the application of knowledge to real-world contexts [5]. In contrast, non-formal educational environments provide opportunities for more flexible, participatory and context-based learning experiences, where ethical dimensions can be explored through narrative, emotion and interaction.

The literature suggests that drama-based and embodied approaches can facilitate the understanding of complex scientific and ethical issues by lowering conceptual barriers and promoting empathy, perspective-taking and engagement [6,7,8]. Nevertheless, empirical evidence on younger children's ability to meaningfully engage with bioethical and geoethical issues remains limited.

This study addresses this gap by exploring whether primary school children, as audience members of a mediated non-formal educational intervention, can recognise, interpret and apply ethical dimensions related to science. The research question that guided this study was: To what extent can young children identify and engage with bioethical and geoethical issues through mediated, narrative-based non-formal science education experiences?

2. Theoretical Framework

2.1 Bioethics and Geoethics in Science Education

Bioethics and geoethics have emerged as key frameworks for addressing ethical challenges associated with scientific and technological development and human interactions with the Earth system. While bioethics focuses on life sciences, health and human dignity, geoethics extends ethical reflection to environmental responsibility, sustainability and intergenerational justice [9,10].
The integration of ethical dimensions into science education is increasingly recognised as essential for preparing students to engage with complex socioscientific issues (SSI) and to act as informed and responsible citizens [4,5,11]. SSI are characterised by uncertainty, conflicting values and the need to evaluate risks, making them particularly relevant for developing students' capacity to reason about real-world problems [12]. Research shows that SSI-based approaches promote critical thinking, argumentation and ethical reasoning, although their implementation remains uneven [13].
Evidence also indicates that SSI can be meaningfully integrated into primary education when connected to real-world contexts and supported by appropriate strategies [14]. In this context, bioethics and geoethics contribute to the development of moral reasoning and awareness of the ethical implications of scientific and environmental issues.
Despite these advances, their integration into early science education remains limited [15,16,17,18]. Although research suggests that children can engage with ethical reasoning and perspective-taking [19,20], these domains are often considered too abstract for younger learners. As a result, ethical discussions are frequently postponed, limiting opportunities for early development of ethical awareness.

2.2 Non-Formal and Mediated Learning Approaches

Non-formal education offers a complementary space to formal schooling, enabling participatory, contextualised and experiential learning. Such environments provide the flexibility to explore complex, interdisciplinary topics, including the ethical dimensions of science, in ways that are accessible and meaningful, particularly in contexts of social inclusion [21,22].
Mediated learning approaches are particularly relevant for addressing abstract concepts such as bioethical and geoethical issues. These approaches rely on narratives, interaction and guided interpretation, aligning with socio-constructivist perspectives that emphasise the role of dialogue and cultural tools in learning [23,24]. Intergenerational contexts further enhance relevance and engagement among younger learners.
Drama-based learning represents a powerful strategy within this framework. By combining storytelling, role-play, and emotional engagement, this approach allows learners to explore socioscientific issues in meaningful, situated contexts, supporting ethical reasoning and consideration of different perspectives [6,7]. Research shows that such approaches integrate cognitive, affective and social dimensions of learning and promote empathy and moral reflection [25,26].
Narrative and symbolic representations function as mediating tools that translate complex concepts into accessible experiences. The use of metaphors and analogies supports ethical reasoning and decision-making, particularly among younger learners [27,28,29]. These processes can be understood through sensemaking and mental models, which allow individuals to interpret complex situations without relying on fully articulated conceptual knowledge [30,31].
Taken together, non-formal, mediated and narrative-based approaches create conditions for the emergence of mediated ethical understanding, in which learners can recognise and respond to ethical dimensions of science without necessarily mastering formal concepts. The conceptual model guiding this study is presented in Figure 1.



Fig. 1. Conceptual model of mediated ethical understanding in non-formal science education.

3. Methodology

3.1 Research Design

This study adopts a mixed-methods approach within an exploratory case study design to examine how young children engage with bioethical and geoethical issues when exposed to a mediated, narrative-based non-formal educational intervention.
The study focuses on a convenience sample of 24 children (ages 6–12) attending the first and second cycles of basic education. They participated as audience members rather than as direct contributors to the intervention design. This distinction is relevant, as it allows for the examination of how ethical understanding may emerge through indirect, mediated experiences.
This design is consistent with established approaches in educational research that combine qualitative and quantitative data to provide a more comprehensive understanding of complex learning processes [32,33].

3.2 Educational Context and Intervention

The study was conducted in a non-formal educational context at a social support institution in an urban area characterised by socio-economic disadvantage. Such contexts are particularly relevant for exploring inclusive educational approaches, as they provide opportunities to engage learners who may have limited access to formal enrichment activities. Research highlights the importance of promoting social inclusion and supporting the development of moral reasoning from early stages, particularly by addressing children's epistemic beliefs and their capacity to engage with ethical issues [34,35].
The intervention was embedded in an intergenerational science education project, in which adolescents designed and performed a theatre play addressing bioethical and geoethical dilemmas. The play explored themes such as animal experimentation, environmental sustainability and human responsibility towards the Earth system.
Following the performance, younger children participated in two complementary activities: (i) a ludic evaluation task using emoji-based response cards to assess their responses to ethical statements, immediately after the theatre and (ii) semi-structured focus group interviews. Data collection from the interviews took place approximately 8 days after the performance, allowing for some reflection while maintaining proximity to the experience.

3.3 Data Collection and Analysis

Data were collected from multiple sources to enable triangulation. Quantitative data were obtained from participants' responses to an emoji-card activity comprising 10 items addressing bioethical, geoethical, and combined issues. Items were presented orally by a narrator and included both statements and questions. Participants responded individually using coloured cards: green (smiling emoji) to indicate agreement or an affirmative response, yellow (confused emoji) to indicate uncertainty, and red (angry emoji) to indicate disagreement or a negative response.
Examples of items included "A scientist should conduct experiments on animals without considering their well-being or level of suffering", "If a company discharges toxic waste into a river, causing harm to ecosystems and drinking water, is this an ethical practice?", and "Learning about the impacts of electronic waste on human health and the environment contributes to more ethical behaviour".
Participants' responses were recorded using an observation grid by two researchers positioned at different points in the room, allowing full visibility of all participants' responses. This procedure supported accurate data recording and reduced the risk of observational bias.
Qualitative data included transcriptions of two semi-structured focus group interviews with 18 participants. The groups were organised according to age and educational level: one group included 12 children attending the first cycle of basic education (ages 6–10), and the other included 6 children attending the second cycle (ages 10–12). Group formation accounted for age-related differences in cognitive and social development. The number of participants was determined by availability on the scheduled day of data collection. Additional interviews were conducted with institutional educators to provide complementary perspectives.
Quantitative data were analysed descriptively to identify patterns across bioethical, geoethical and combined categories. Qualitative data were examined through thematic content analysis, focusing on three dimensions: (i) recognition of ethical concepts, (ii) application of ethical reasoning in context, and (iii) emotional engagement and interpretation.

This combined approach enabled a comprehensive understanding of how participants engaged with ethical dimensions of science, integrating response patterns with interpretative insights.

4. Results and Discussion

The findings of this study indicate that young children can engage with bioethical and geoethical issues when presented through mediated, narrative-based approaches. Following the mixed-methods design, the baseline capacity for ethical identification is established quantitatively, followed by an in-depth qualitative analysis of the children's reasoning and retention.

4.1 Quantitative Findings: Immediate Identification of Ethical Dimensions

The results of the immediate emoji-card activity provide substantial evidence of the participants' capacity for ethical decision-making, as detailed in Table 1.

Table 1. Results of the emoji-card activity.

Category	Correct answer (%)	Uncertain (%)	Incorrect (%)
Bioethical topic	95.8	4.2	0.0
Geoethical topic	80.2	19.8	0.0
Combined topics	81.2	18.8	0.0

High levels of correct responses were observed across all categories, particularly in bioethical statements (95.8%), with slightly lower but consistent results in geoethical (80.2%) and combined categories (81.2%). The slightly lower results observed in geoethical and combined categories may reflect the greater level of abstraction and systems thinking required to interpret environmental and human–Earth interactions, compared to more immediate and relational bioethical issues. Notably, no incorrect responses were recorded, with remaining answers reflecting uncertainty rather than misunderstanding.

These results suggest that children in early stages of education are capable of recognising simple bioethical and geoethical principles when supported by appropriate pedagogical frameworks. This finding is consistent with previous research indicating the feasibility of ethics education in primary contexts [37,38], as well as recent reviews highlighting the development of argumentative and value-based reasoning from early school years [39]. In addition, studies show that younger learners construct meaning in scientific contexts through a combination of linguistic and non-linguistic resources, reinforcing the importance of multimodal and inclusive approaches [40], such as the emoji activity implemented here.

4.2 Qualitative Findings: Engagement, Applied Reasoning, and Educational Perspectives

To ascertain whether this high level of immediate identification translated into sustained reasoning and deeper ethical internalization, the focus groups conducted 8 days later were analyzed. Overall, participants demonstrated high levels of lingering engagement with the theatre-based intervention, expressing interest and valuing the opportunity to actively participate in the final decision-making process. Interactive elements, such as the voting component, were frequently highlighted as meaningful, suggesting that participation played a key role in sustaining attention and involvement over time. As one participant recalled, "[the voting component] brought more fun to the theatre" (Participant 6), while another argued that "... it was great" (Participant 14).

Despite the high identification success shown in the emoji activity, the qualitative data revealed that most participants had no prior familiarity with the concepts of *bioethics* and *geoethics*. None were able to provide formal definitions; however, when reflecting on the play a week later, many demonstrated an incipient applied understanding by using core values such as "care" (Participant 6), "protection" (Participant 5) or "responsibility" (Participant 12).

This distinction between formal conceptual knowledge and applied understanding is particularly significant. While conceptual mastery was absent, participants were nevertheless able to recognise ethical dimensions and interpret their meaning in context. This finding aligns with research on socioscientific decision-making, which conceptualises decision processes as multidimensional, involving the integration of knowledge, values, personal experiences and contextual factors [31]. From this perspective, ethical reasoning does not depend solely on formal conceptual understanding but can emerge through processes of interpretation and judgement. Similarly, studies on sensemaking and

mental models suggest that individuals rely on simplified representations to interpret complex situations and guide action [30].
Participants also demonstrated the ability to apply ethical reasoning to everyday situations, reflecting on issues such as animal welfare, environmental responsibility and social behaviour. However, difficulties were observed in generating explicit examples outside the scope of the play, indicating that while recognition and interpretation were present, the ability to independently articulate abstract ethical issues remained limited. This pattern suggests that early ethical understanding may be grounded in contextual and experience-based reasoning, rather than abstract conceptualisation.
Furthermore, the use of theatre appears to have facilitated access to complex issues by combining storytelling, emotion and interaction, allowing participants to engage with dilemmas in a situated and meaningful way. This is consistent with research indicating that narrative, metaphor and analogy can support ethical reasoning and decision-making by structuring how learners interpret and respond to complex situations [27,28,29]. In the context of socioscientific issues, science itself functions as a key epistemic resource for ethical reasoning [35]. In addition, participants demonstrated elements of perspective-taking, considering different viewpoints and reflecting on the consequences of actions. These findings are consistent with recent research showing that children can engage in perspective-taking and socioscientific decision-making when supported by contextualised learning environments [34], as well as earlier work highlighting the emergence of moral and environmental reasoning in primary education [36].
The intergenerational nature of the intervention appears to have further contributed to its effectiveness. Younger participants engaged with content produced by older peers, enhancing identification, motivation and relevance. This dynamic reflects socially mediated learning processes, in which meaning is co-constructed through interaction and shared experience.
Furthermore, the perspectives from institutional educators reinforce these findings. In individual interviews, all professionals (n=3) reported clear benefits of the intervention for younger participants, particularly in terms of long-term engagement, ethical awareness and the development of critical thinking. As one educator noted, “it is a much more engaging way for them to understand what is being discussed… these are not easy topics” (Educator 1). Another educator emphasised that the experience “left something that could awaken them to what they should or should not do”. The same participant added that it is important “to start introducing them to these topics from a very young age, as I think they are very relevant” (Educator 2).
On the other hand, educators expressed differing views on the most appropriate age to introduce bioethical and geoethical concepts. While one suggested that these topics can be introduced in the later years of primary education (1st cycle of basic education), provided they are approached gradually and in accessible ways (Educator 2), another mentioned the 2nd cycle of basic education (Educator 3), and another argued that greater cognitive maturity is required for deeper understanding, suggesting that these topics should only be addressed at secondary school level (Educator 1).
This reflects a tension also identified in the literature. On the one hand, research in early childhood education highlights that children are capable of engaging in ethical reasoning, perspective-taking and socio-emotional reflection [20,21]. On the other hand, the depth and complexity of ethical understanding are heavily influenced by cognitive development and maturity [3].

4.3 Synthesis and Conceptual Contribution

Taken together, the quantitative metrics and qualitative indicators suggest that young learners can develop early forms of ethical understanding when exposed to mediated, narrative-based and contextually meaningful learning environments. This supports the notion of *mediated ethical understanding*, in which learners can recognise and meaningfully respond to the ethical dimensions of science without necessarily mastering formal conceptual definitions. Additionally, our findings suggest that early exposure to ethically rich, narrative-based experiences may play a role in bridging the gap between scientific understanding and responsible action in young learners.
These results challenge traditional assumptions that ethical learning depends primarily on conceptual knowledge. Instead, they highlight the central role of engagement, interpretation and contextualisation in early science education.
Several limitations should be acknowledged. The study was conducted with a relatively small sample in a specific non-formal context, which may limit the generalisability of the findings. In addition, the short time frame between the intervention and data collection does not allow for the assessment of long-term learning effects.

5. Conclusions and Implications

This investigation examined how young children engage with bioethical and geoethical issues when exposed to a mediated, narrative-based non-formal educational intervention. Although participants did not demonstrate formal conceptual understanding, they showed a clear ability to identify ethical dimensions, apply contextual reasoning, and make value-based decisions.

These results support the notion that ethical learning in early stages does not depend primarily on conceptual mastery, but can emerge through engagement with meaningful, contextualised and emotionally resonant experiences. In this study, the use of theatre as a pedagogical tool, combined with interactive and intergenerational dynamics, appears to have played a central role in facilitating access to complex socioscientific issues.

From an educational perspective, the findings suggest that bioethical and geoethical dimensions can be meaningfully introduced in primary education, provided that age-appropriate and mediated approaches are used. Narrative-based strategies, such as drama, storytelling or visual representations, offer effective pathways to foster ethical engagement, particularly by promoting empathy, perspective-taking and reflective thinking.

At the same time, the results highlight the importance of recognising developmental differences. While younger learners can interpret and respond to ethical situations, the depth of understanding and the capacity for abstract conceptualisation remain limited. This suggests that ethical education should be introduced progressively, balancing accessibility with increasing conceptual complexity.

This study contributes to the field by providing empirical evidence for integrating ethical dimensions into early science education through non-formal and mediated approaches. It also introduces the concept of mediated ethical understanding as a useful framework to describe how learners engage with ethical issues in the absence of formal conceptual knowledge.

Future research should explore how these approaches can be adapted to formal educational settings and diverse learner populations, and examine their long-term impact on ethical reasoning, scientific literacy, and responsible citizenship. Further studies could also investigate how the progressive integration of conceptual knowledge may build upon early forms of mediated ethical understanding.

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Child as Co-Author: Interdisciplinary Integration of Visual Arts and Media Literacy in Early Childhood Education

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Abstract

This paper examines the interdisciplinary integration of visual arts and media literacy in early childhood education, grounded in the concept of the child as a co-author in the process of meaning-making. Drawing on contemporary approaches to media literacy, visual culture, and constructivist pedagogy, the study positions the child as an active constructor of knowledge rather than a passive recipient of media content. The empirical part presents a qualitative case study of a six-year-old child who, after reading a story written by one of the authors, developed a narrative interpretation and translated it into a series of original illustrations. The analysis explores the relationship between verbal narrative and visual representation, focusing on how the child identifies and interprets elements of media messages—such as color, characters, emotional tone, and communicative intention—and reconfigures them through artistic expression. The findings suggest that integrating visual arts with media literacy supports the development of critical thinking, visual analysis, and creative interpretation. The child emerges as an active interpreter and co-author of meaning, highlighting the pedagogical value of artistic production in fostering early media competence and supporting interdisciplinary approaches in early education.

Keywords: *media literacy; visual arts; early childhood education; child as co-author; constructivism; case study*

1. Introduction

Children today grow up in a highly visual, media-saturated environment shaped by digital media, advertising, and public visual communication, all of which influence their perceptions and understanding of the world [4], [14]. Visual messages, particularly advertisements, function as complex systems of meaning that use symbolic and affective strategies to shape viewers' responses. Although often perceived as passive recipients, children actively interpret and negotiate media meanings within their social contexts, thereby calling for recognition of their capacity as meaning-makers [6].

Media literacy, defined as the ability to access, analyze, evaluate, and create media messages, is therefore essential from an early age [1], [10]. Research shows that even young children begin to understand persuasive intent, although their critical evaluation skills are still developing, so it is important to develop appropriate approaches in early education [15].

Visual arts offer a valuable pathway for fostering such competencies because artistic expression enables children to interpret and transform visual information. Grounded in constructivist perspectives, this study explores how integrating visual arts and media literacy supports children's interpretative abilities and examines how a child uses illustration to reconstruct a media message, positioning the child as a co-author of meaning within a multimodal framework [12], [13].

2. Theoretical Background

Contemporary pedagogical theories increasingly reject the notion of the child as a passive recipient of knowledge, instead positioning the child as an active participant in meaning-making. This perspective is grounded in the work of Piaget [19] and Vygotsky [25], who emphasize the child's active role in cognitive and symbolic development.

Piaget explains learning as a process of active construction through assimilation and accommodation, in which children interpret new experiences in relation to their existing cognitive structures [19]. In the context of media literacy and visual culture, children do not receive media messages as predetermined meanings but interpret them through their prior experiences and intellectual capacities. Visual expression, such as drawing, serves as a symbolic representation through which children externalize and reorganize their understanding [8].

Vygotsky extends this view by highlighting the social nature of learning, in which knowledge is mediated by interaction and cultural patterns [25]. Dialogue, reflection, and visual production support the development of more complex interpretative abilities, positioning artistic expression as a key medium of meaning-making [12].
A model for such an approach can be found in Reggio Emilia, which conceptualizes the child as competent, expressive, and capable of constructing meaning through multiple symbolic systems, as reflected in the concept of the "hundred languages of the child." [16], [20]. Learning is understood as a collaborative and interpretative process, with the adult acting as mentor rather than transmitter of knowledge.
Within this model, the concept of the child as a co-author emerges. Co-authorship aligns with participatory and democratic education, especially in foregrounding children's interpretations and shaping meaning rather than reproducing content [6].
In visual culture and media literacy contexts, this is particularly evident. Visual production enables children to construct and communicate their own perspectives, positioning them as active participants in visual culture [9]. Meaning is not inherent in images but emerges through interaction between the viewer and the visual text [23]. Through drawing and illustration, children select, emphasize, and transform elements, revealing both understanding and a critical attitude.
In interdisciplinary contexts that integrate visual arts and media literacy, children engage in multimodal meaning-making, in which their visual choices serve as indicators of agency and interpretation. Co-authorship provides a framework for understanding children's visual and narrative productions as the main arenas for meaning-making, positioning the child as an active participant within contemporary media environments.

2.1 From Perception to Interpretation: Media Literacy in Early Childhood

Media literacy is widely recognized as a fundamental competence in contemporary societies, encompassing the ability to access, analyze, evaluate, and create media messages [1], [10]. UNESCO further expands this concept by integrating media and information literacy, emphasizing an understanding of how media content is produced and situated within broader social and cultural contexts [24].
Contemporary approaches highlight the critical dimension of media literacy. As Buckingham argues, media literacy involves understanding representation, media language, audience, and production processes [4]. Developing media literacy requires recognizing how meaning is constructed and how spectators are positioned.
Important to this study is the shift from perception to interpretation. While perception refers to initial engagement with media, interpretation involves active cognitive and semiotic processing, questioning how meaning is constructed and why certain elements are emphasized. This approach is similar to constructivist and sociocultural perspectives on learning [3], [25].
Research shows that children begin to recognize persuasive intent between ages six and eight, although their critical evaluation remains limited [15]. It highlights the need for pedagogical approaches that move beyond awareness toward interpretative engagement.
Recent scholarship advocates moving from protectionist to empowerment-oriented models of media literacy, supporting children as active participants in media culture [5], [10]. Given children's frequent engagement with visual media, developing visual interpretative skills is essential. As Kress notes, meaning is increasingly constructed multimodally, requiring the ability to interpret visual and spatial elements [12].
Pedagogically, this implies integrating analysis with creative production. Activities such as discussing advertisements and reconstructing media messages through drawing enable children to externalize and reflect on their interpretations [11].
Within interdisciplinary contexts, particularly those that combine visual arts and media literacy, this progression becomes evident. By creating their own visuals, children can reshape media messages. It shows what they understand and turns them into active participants. Media literacy thus emerges as a multimodal, participatory practice that supports the development of critical awareness and the child's role as a co-author of meaning.

2.2 Drawing Meaning: Visual Arts as a Critical Literacy Practice

Given the central role of images in contemporary culture, media literacy necessarily includes the development of visual literacy, the ability to interpret, analyze, and construct meaning through visual elements such as color, composition, and symbolism [9], [23].
Visual culture theory emphasizes that meaning emerges through interaction between the image and the viewer within specific cultural contexts [23]. In educational settings, this involves encouraging children to question who created a message, for whom, and with what intent. Such inquiry supports the shift from perception to interpretation.
Duncum highlights the importance of engaging with media images in education, advocating a move from passive viewing to active interpretation [7]. When children reinterpret visual messages through artistic expression, critical reading becomes visible in their visual choices. In this study, illustration is therefore understood not as reproduction but as an interpretative act that transforms narrative meaning into visual form.
The sequential nature of illustrations further supports meaning-making by structuring temporal and causal relationships. It allows insight into how children organize and develop understanding over time. Illustrated sequences provide insight into how children organize and interpret meaning.
Visual arts can thus be seen as a critical literacy practice. Drawing supports symbolic thinking [19] and operates as a cultural tool for meaning-making [25], enabling children to reinterpret and transform visual information [12]. As Eisner argues, artistic activity fosters forms of thinking essential for interpretation and judgment [8].
Through visual production, children engage in processes of selection, evaluation, and transformation, which are considered core aspects of critical literacy [12], [21]. In interdisciplinary contexts, particularly those integrating visual arts and media literacy, drawing makes children's interpretations visible and positions them as active meaning-makers and co-authors within visual culture.

2.3 Illustration as an Interpretative Act

Picturebook illustration, particularly within a narrative sequence, represents a form of visual interpretation rather than a neutral reproduction of text. Illustrations construct and transform meaning by introducing visual, spatial, and affective dimensions. As such, illustration can be understood as a semiotic practice in which meaning is rearticulated through visual choices.
Visual production enables learners to develop personal perspectives and negotiate meaning within cultural contexts [9]. When children translate narrative into images, meaning is transformed rather than transferred [12]. Picturebook theory further emphasizes the dynamic relationship between text and image, where illustrations may complement, expand, or challenge the verbal narrative [17], [18].
Meaning, therefore, emerges through interaction between the image and the viewer [23]. Illustration thus functions as a visible trace of cognitive and interpretative processes. As Arizpe and Styles show, children actively engage with visual narratives, bringing personal and cultural understandings into their interpretations [2]. It becomes particularly evident in sequential illustration, where organizing events across images requires an understanding of temporal progression, causality, and narrative coherence [17].
Such processes position illustration as a multimodal practice through which children organize and negotiate meaning. By selecting, omitting, or reconfiguring elements, children reveal their interpretative strategies and critical engagement. In this sense, illustration becomes an analytically relevant site where media literacy, symbolic thinking, and agency are made visible.
Within this study, the creation of an illustrated narrative based on a misleading advertisement provides insight into how a child reconstructs media messages. The illustrations function as multimodal texts that reveal how perception is transformed into interpretation.
Illustration should therefore be understood not as a supplementary activity but as an interpretative act central to meaning-making. This perspective aligns with the concept of the child as a co-author, positioning visual production as a key site for constructing, negotiating, and transforming meaning.

3. Methodology

This qualitative case study aims to gain an in-depth understanding of how a child constructs and reinterprets media messages through visual expression. A qualitative approach was selected as it enables the exploration of meaning-making processes, symbolic structures, and interpretative practices,

in line with constructivist perspectives that conceptualize the child as an active agent in knowledge construction [3], [25].
The case study methodology allows for a detailed, context-sensitive analysis of a specific phenomenon within its natural setting [22], [26]. In this research, the phenomenon under investigation is the multimodal interpretation of media content through children's illustrations, understood as an interdisciplinary form of meaning-making that connects media literacy and visual arts.

3.1 Participant and Research Context

The participant in the study is a seven-year-old boy. The research was conducted in an educational context through a structured activity that supported both interpretation and creative expression. The activity consisted of three phases:

1. Reading the story *Adbad's Secret Plan*,
2. Producing a series of illustrations based on the narrative.
3. Engaging in a reflective conversation about the created illustrations.

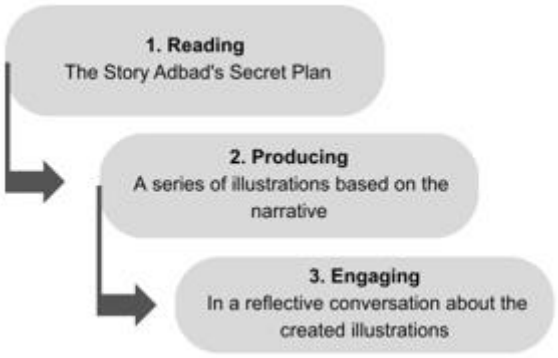


Fig. 1. Research activity sequence: reading the story, producing illustrations, and reflective conversation

This sequence enabled the collection of both visual and verbal data, allowing examination of relationships among narrative understanding, emotional engagement, and visual representation.

3.2 Analytical Framework: Multimodal Social Semiotic Approach

The analysis was conducted using a multimodal approach grounded in social semiotics [12], [13]. From this perspective, meaning is understood as emerging through the interaction of different semiotic modes, such as language and image, each offering specific affordances for meaning-making.
A mode is defined as a socially and culturally shaped resource for meaning-making [12]. In this study, particular attention is given to the interaction between the verbal mode (narrative) and the visual mode (illustration), through which the child reinterprets the media message.
Rather than treating illustration as a simple translation of the narrative, it is approached as a transformative multimodal act, in which meaning is reconfigured across modes. It aligns with a social semiotic understanding of communication as a process of design, where individuals actively shape meaning through the selection and organization of semiotic resources [12].
To systematically analyze the visual data, the study applies Kress and van Leeuwen's model of visual grammar, organized around three metafunctions: the representational, interpersonal, and compositional [13].

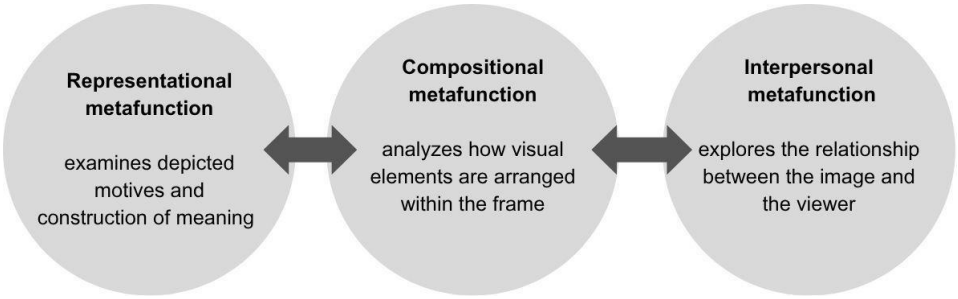


Fig. 2. Kress and van Leeuwen's (2006) model of visual grammar.

These dimensions do not operate independently but interact to produce meaning, enabling the analysis to capture how visual, narrative, and symbolic elements are orchestrated within the illustrations [11].
The analysis was conducted in an interpretative and iterative manner, integrating visual and verbal data. The illustrations were examined in relation to the narrative content and the child's reflections, with particular attention to:

- the selection and emphasis of visual elements,
- the transformation or reinterpretation of narrative content,
- the use of symbolic strategies (e.g., exaggeration, abstraction),
- and the organization of meaning across the sequence of images.

This approach allowed for the identification of indicators of media literacy, such as recognition of persuasive intent, awareness of emotional appeal, and the emergence of critical distance.
At the same time, the analysis focused on moments of interpretative agency, examining how the child actively reorganizes and transforms meaning across modes. In this sense, the illustrations were treated as multimodal texts that make visible the child's meaning-making processes and support the conceptualization of the child as a co-author of meaning.

4. Results: Multimodal Analysis of Children's Illustrations

The multimodal analysis of the two illustrations reveals a clear progression in the child's understanding and reinterpretation of the media message. Across the representational, interpersonal, and compositional dimensions, the findings indicate a shift from perceptual engagement toward critical interpretation.

4.1 Perceptual Engagement with the Media Message

Figure 3 depicts children standing in front of a large roadside poster featuring a football player. At the representational level, three key elements are present: the observing children, the poster, and the media figure. The football player is shown in motion, kicking a ball, enhancing the image's dynamic and appealing character. The act of looking, in which one of the children directs attention to the poster, establishes a simple narrative of engagement with the media content.
A notable feature is the poster's exaggerated scale relative to the surrounding environment. Its size surpasses that of nearby houses and figures, visually signaling its dominance. This disproportion suggests how media messages occupy and control visual space. At the same time, the contrast between the everyday setting and the idealized image on the poster introduces a distinction between lived reality and mediated representation.
From an interpersonal perspective, the illustration constructs an indirect relationship with the viewer. The football player does not engage with the gaze but is absorbed in the action, while one of the children focuses on the poster. This positioning situates the viewer as an observer rather than a participant. The emotional dimension is conveyed through the child's attentive stance and the accompanying narrative, both of which indicate fascination. It reflects sensitivity to the advertisement's emotional appeal, though without clear critical distance.
Compositional analysis reinforces the prominence of the media message. The poster occupies a central, visually dominant position, while the children appear smaller and lower in the frame. Strong color contrasts further highlight the poster as the focal point. The spatial separation between the everyday environment and the media image emphasizes the latter as the primary carrier of meaning.

Overall, the illustration suggests that the children recognize the advertisement's attractiveness and visual power but engages with it primarily at a perceptual level. It corresponds to an early stage of media literacy, characterized by awareness of appeal rather than critical evaluation.

4.2 Critical Reinterpretation and Deconstruction

Figure 4 demonstrates a significant transformation in the representation of the media message. The previously appealing football player is replaced by a simplified, dark figure with a skull-like face and an "X" over the mouth, marking a shift from realistic depiction to symbolic abstraction.
At the representational level, the focus moves from action to meaning. The figure functions as a visual metaphor for deception, danger, or concealed intent. Its stylized form and raised arms contribute to a sense of tension and exposure, suggesting that the child is engaging with the media message's underlying implications rather than its surface features.
The interpersonal dimension also changes. The simplified, abstract representation reduces emotional identification, creating distance and unease instead. Unlike the first illustration, which invites admiration, this image evokes reflection and discomfort. The accompanying text reinforces this shift by introducing themes of fear and secrecy, further supporting a critical stance toward the message.
Compositional features intensify this reinterpretation. The poster remains central, but the surrounding environment is significantly reduced or omitted, isolating the media message. The use of darker, monochromatic tones within the poster contrasts sharply with the background, emphasizing its seriousness and symbolic weight. This visual simplification directs attention exclusively to the message's meaning.
The advertisement is no longer represented as attractive but as deceptive and potentially harmful. Through abstraction, symbolism, and selective emphasis, the child demonstrates the ability to reinterpret and transform the original message.



Fig. 3. Child-produced illustration inspired by the story *Adbad's Secret Plan*: a boy and a girl observing the poster

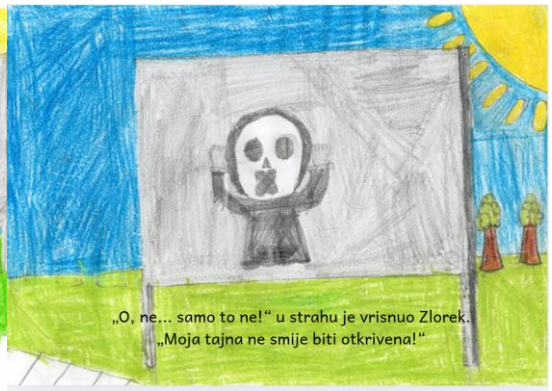


Fig. 4. Child-produced illustration inspired by the story *Adbad's Secret Plan*: Adbad as the central figure

5. Discussion

The findings of this study contribute to ongoing discussions on early media literacy, visual arts education, and the conceptualization of the child as an active meaning-maker. By analyzing children's illustrations as multimodal texts, this research demonstrates how visual production can function as a site of interpretation, transformation, and critical engagement with media content.
A key finding is the shift from perceptual engagement to interpretative and critical understanding. As the analysis shows, the illustration in Fig. 3 reflects the visual logic of advertising, emphasizing attractiveness, scale, and emotional appeal. In contrast, the second illustration reconfigures these same elements to expose manipulation and hidden intent.
This shift reflects a movement from representation to transformation. The child does not merely replicate the given narrative but actively reorganizes its meaning through visual means. The introduction of symbolic elements, the simplification of form, and the recontextualization of the poster all indicate interpretative agency.
This progression aligns with developmental perspectives on media literacy, which suggest that children initially engage with media at the surface level before gradually developing the capacity for critical

evaluation [15]. However, the present findings extend this understanding by demonstrating that such critical awareness can emerge earlier when children are supported through structured, multimodal learning experiences. The use of visual expression appears to facilitate this transition by enabling children to externalize and reflect upon their interpretations.

From a multimodal perspective, this process can be understood as a transformation of meaning across modes. The narrative is first encountered verbally, then interpreted cognitively and emotionally, and finally rearticulated visually. Each stage involves reinterpretation, rather than simple translation [12]. It supports the view that meaning-making is not linear but dynamic and recursive, involving continuous negotiation between different semiotic resources [11].

The findings also reinforce theoretical perspectives in visual culture studies, which emphasize that meaning is not inherent in the image but is constructed through the interaction between the viewer and the visual text [23]. In this study, the child's illustrations reveal how this interaction becomes productive: the child does not passively receive the media message but actively reshapes it, introducing new symbolic elements and altering its meaning.

Through visual production, the child participates in reconstructing the media message, demonstrating not only understanding but also critical positioning. The illustrations thus function as multimodal texts that make visible the child's interpretative processes and emerging media literacy.

Importantly, this supports pedagogical approaches that position children as competent and agentive participants in learning processes, as advocated in sociocultural and Reggio Emilia-inspired frameworks [16], [20], [25]. The child's ability to reinterpret and transform the media message suggests that even at an early age, children can engage in complex semiotic practices when provided with appropriate scaffolding and opportunities for expression.

The role of the visual arts in this process is particularly significant. Consistent with Eisner's argument that artistic activity fosters forms of thinking essential for interpretation and judgment, the act of illustration enabled the child to analyze, evaluate, and reconstruct the media message [8]. Rather than functioning as a supplementary activity, drawing served as a primary mode of inquiry and critical reflection.

Furthermore, the findings highlight the importance of interdisciplinary integration. By combining narrative, visual expression, and media analysis, the learning process becomes multimodal and dialogic. It supports arguments that media literacy education should move beyond analytical exercises toward creative and participatory practices [5], [10]. The integration of visual arts and media literacy provides a pedagogical framework in which interpretation and production are mutually reinforced.

At the same time, the study has limitations that should be acknowledged. As a single case study, the findings cannot be generalized to broader populations. The interpretation is also context-dependent and influenced by the specific task, narrative, and interaction with the researcher. Future research could explore similar approaches with larger sample sizes, across different age groups, or in varied media contexts to further examine the relationship between visual production and media literacy development.

Despite these limitations, the study offers important implications for educational practice. It suggests that early media literacy education should not be limited to recognizing media messages but should actively engage children in interpreting and reconstructing them. Visual arts, particularly illustration, provide a powerful means of making children's thinking visible and supporting the development of critical awareness.

This study demonstrates that the transition from perception to interpretation can be effectively supported through multimodal and interdisciplinary approaches. By engaging in visual reinterpretation, children move beyond passive reception and become co-authors of meaning, actively participating in the construction and transformation of media messages.

6. Conclusion

This study explored the potential of integrating visual arts and media literacy in early childhood education through a multimodal, case-based approach. By analyzing a child's illustrations as interpretative acts, the research demonstrated how visual expression can function as a powerful tool for meaning-making and critical engagement with media content.

The findings indicate that children can move from perceptual engagement with media messages to more complex forms of interpretation when supported by structured, interdisciplinary activities. The progression observed in the illustrations highlights the child's ability to reinterpret and transform the given narrative, revealing emerging critical awareness and interpretative agency.

By conceptualizing illustration as a multimodal practice, this study contributes to understanding how meaning is constructed across modes and how children participate in this process. The results support

the notion of the child as a co-author of meaning, actively engaged in reconstructing media messages rather than passively receiving them.
From a pedagogical perspective, the study underscores the importance of integrating visual arts into media literacy education. Such an approach not only enhances critical thinking but also makes children's interpretations visible and open to reflection.
Future research should explore multimodal and interdisciplinary approaches across contexts and age groups to better understand how early media literacy can be effectively supported in contemporary educational settings.

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Special Needs

The Role of Teachers in Social-Emotional Learning to Support Children with Special Needs in Inclusive Schools

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Abstract

Children with special needs still often receive discrimination even at inclusive schools. Teachers play a very important role in the learning of children with special needs. This study aims to examine the role of teachers in social-emotional learning (SEL) to support development in the primary school environment. This research uses a descriptive qualitative design. Data was collected through observation, semi-structured interviews, and document analysis. The validity of the data is ensured through triangulation of sources and techniques. Data analysis follows the Miles and Huberman model consists of data reduction, data presentation, and conclusion drawn. The results show that teachers have a role in teachers' social-emotional learning, including as Facilitators of Emotional Regulation, Models of Positive Social Behavior, Mediators of Social Interaction, and Supporters of Individual Emotional Needs. SEL can increase the involvement of students with special needs in classroom activities and help them manage their emotions and interact with peers. This research can provide an understanding of the role of teachers in the implementation of SEL in the context of inclusive education and become a reference for schools and educators in designing SEL strategies that are more adaptive and oriented to the individual needs of students with special needs.

Keywords: *SDGS 16, Children with Special Needs, elementary schools, inclusive schools, peace and justice, SEL, teachers*

1. Introduction

Teachers play a very important role in the learning of children with special needs (CSN). Teachers can facilitate learning that helps children with special needs reach their full potential [1], [2]. Teacher involvement can have an impact on the quality of learning [3]. Teachers in inclusive classrooms must be able to provide physical and non-physical access that ensures all students participate in educational activities without limitations [4]. Teachers often face challenges in dealing with children with special needs in regular classrooms [5].

The right to fair and quality education applies to all children [6], [7] including children with special needs [8]–[10]. This is in line with the Convention on the Rights of the Child, which emphasizes that every child has the right to learn in a safe and discrimination-free environment [11]. Inclusive education can be a key strategy to ensure every child gets a quality education in a supportive environment without discrimination. Inclusive education prioritizes diversity and equal educational opportunities for all learners regardless of their differences [12], [13]. Inclusive education attaches importance to children's right to participate without exception [14] and requiring schools to accept children without discrimination to ensure access to quality education [15]. Inclusive education supports the development of language, communication, social, academic skills [16], and fostering positive attitudes for children with special needs in the social environment [17], [18].

Currently, in Indonesia all schools are required to accept all students without exception, including Children with Special Needs. Article 31 of the 1945 Constitution and the National Education System Law affirm the right to education for all citizens without discrimination. The Government of Indonesia through the Regulation of the Minister of National Education Number 70 of 2009 has regulated and developed programs to promote inclusive education [19]. Regulation of the Minister of National Education of Indonesia No. 70 of 2009 states that each district/city must appoint at least one elementary and junior high school in each sub-district as an inclusive school, as well as a minimum of one high school per district/city [20], [21].

Social-Emotional Learning can be one of the educational approaches that focuses on developing students' social and emotional competencies. SEL is able to support the cognitive and emotional aspects of student learning [22]. SEL programs help children with special needs develop emotional competencies and social skills, which are essential for emotional development and social inclusion. Social-emotional learning can be one of the educational approaches that focuses on developing students' social and emotional competencies. SEL has 5 main components, including Self-Awareness, Self-Management, Relationship Skills, Social Awareness, Responsible Decision Making [23], [24]. An effective SEL program integrated into the school curriculum can provide appropriate learning for students [25], [26]. Research shows that SEL can contribute to academic improvement by improving students' emotional intelligence and interpersonal skills [27], [28].

However, the reality is that not all teachers understand and implement SEL in learning. This is supported by the opinion of Mithans et al. [29] that there are still many teachers who feel that they do not have adequate competence to effectively teach children with special needs. Effective SEL implementation requires specialized training and quality resources [30]. Supportive school leadership is also critical in creating an environment conducive to SEL [31]. Continuous professional development and training is important for teachers to feel confident and competent in implementing SEL [32].

In inclusive education, teachers should be able to accommodate CSN learning in learning. But in reality, learning is still equated with regular students. This is because teachers often lack the necessary training to effectively support students with special needs [33]–[35]. Public attitudes and stigma towards disability also hinder the effective implementation of inclusive education [36]–[38]. Collaboration between teachers, support staff, parents, and the community is needed to create a supportive and inclusive learning environment [39], [40].

This research is important because children with special needs need to receive appropriate social-emotional support in inclusive schools, in order to improve the quality of teaching and reduce educational gaps. In addition, the child's mental well-being is important for long-term development. The results of the research can provide data to help policymakers formulate more responsive and inclusive education policies. Research related to SEL studies has been extensively conducted, including research by Heyder [41] which examines teachers' attitudes towards inclusive education related to students' SEL in elementary school. Research by Wui [42] researched the effectiveness of SEL for children with special needs in Northern California Elementary Schools. Research on SEL strategies at the high school level [43], and the development of SEL to support children with special needs in regular schools and special schools [44]. However, there has not been much research related to the role of teachers in SEL to support children with special needs in inclusive schools. The novelty of this research lies in the exploration of the role of teachers in SEL to support children with special needs in inclusive schools. This study aims to examine the role of teachers in social-emotional learning (SEL) to support development in the elementary school environment. This research is in line with the Sustainable Development Goals goal 16, namely Peace, Justice, and Strong Institutions which emphasizes the importance of inclusive education, a safe, fair, and discrimination-free learning environment, as well as the role of teachers in building a school climate that supports the social and emotional well-being of students.

2. Method

2.1 Research Design

This study uses descriptive qualitative. Descriptive qualitative is used because in this study it is important to describe research findings related to the role of teachers in SEL to support children with special needs in inclusive schools. This is in accordance with the purpose of descriptive qualitative research, which is to explore the "how", "what", or "when" of phenomena and provide detailed insights into specific contexts and experiences [45].

2.2 Research Design

The research was conducted in one of the inclusion schools in the city of Surakarta. The research was conducted in 6 classes by observing the implementation of learning in the inclusion classroom and interviews were conducted with 6 classroom teachers and principals. The profiles of the students with special needs involved are presented in the following table:

Table 1. Types of children with special needs in inclusion schools

Types of Special Needs	Amount
Disturbances in activity and attention	1
Slow Learner	11
Mild mental retardation	9
Typical developmental disorders of speech and language	4
Autism	1
Intellectual Disability	1
Attention deficit disorder	2
Mixed behavioral and emotional disorders	2
Total	**31**

2.3 Data Collection

Data collection is carried out by means of observation, semi-structured interviews, and document analysis. Observations were carried out by observing the participation and involvement of students with special needs in classroom activities, interaction between peers and social inclusion, teachers' strategies in implementing SEL. Interviews were conducted in a structured manner to 6 classroom teachers and principals, as well as parents of CSN. The research questions focus on Perceptions of inclusive educational environments, perceptions of CSN, learning challenges of CSN, Strategies used by teachers to implement social- emotional learning (SEL), and support systems provided by schools and external stakeholders. Document analysis involves reviewing school policies, lesson plans, and other relevant materials to examine the frameworks and strategies used in implementing social-emotional learning.

2.4 Data Analysis

The data were analyzed using an interactive model created by Miles and Huberman. Data analysis techniques include data reduction, data visualization, and conclusion drawing [46]. The data validation technique uses source triangulation techniques and techniques.

3. Result

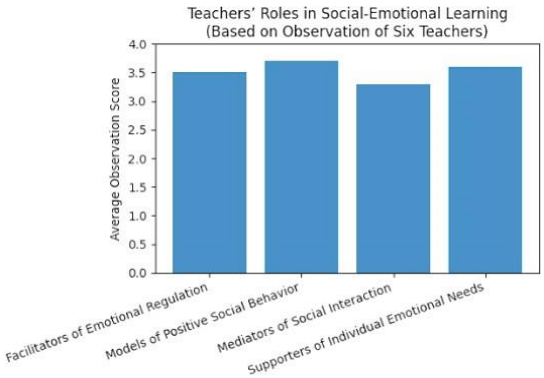


Fig. 1. Results of observation of the role of teachers in SEL

Based on the results of observations, the average score for the role of teachers in Social-Emotional Learning with details of the role of teachers as Facilitators of Emotional Regulation obtained an average score of 3.5 in the category of Excellent. The role of teachers as Models of Positive Social Behavior obtained an average score of 3.7 in the Excellent category. The role of teachers as Mediators of Social Interaction obtained an average score of 3.3 in the Good category. Meanwhile, the role of teachers as Supporters of Individual Emotional Needs obtained an average score of 3.6 in the Very Good category. The categorization of the observation score was determined using the Likert scale interval technique with a score range of 1–4 divided into four categories with an interval of 0.75, so that a score of 1.00–

1.75 was categorized as low, 1.76–2.50 was adequate, 2.51–3.25 was good, and 3.26–4.00 was very good [47].

The role of teachers as facilitators of emotion regulation is observed through the actions of teachers in helping students recognize their emotions, providing guidance to students when they are angry or anxious, teaching strategies to calm down, how teachers respond to students' emotional expressions with an empathetic and non-judgmental attitude, and providing opportunities for students to express their feelings appropriately both verbally and nonverbally. In an interview, one of the teachers stated:

> "I help students recognize and express emotions by first creating a safe and supportive environment first. Then I also teach emotional vocabulary to children so that children understand the emotions that exist and know how to express them. In addition, I also set an example through the expression of positive and healthy emotions what kind of" (R1-10 Jan 2025)

The role of teachers as a model of positive social behavior is observed through the teacher's consistency to be empathetic to all students, the use of polite and respectful language in class interactions, teachers' patience in dealing with learning difficulties and the behavior of students with special needs, teachers' attitudes in respecting differences and diversity in the classroom, and the example of positive social behavior that teachers consistently display in various learning situations. These results are in accordance with the teacher's statement as follows:

> "…. I always give an understanding and example of what is good and what is right to children. I always say that in this life it is very important to always be polite, honest, responsible, and respectful to others. I consistently apply it and can be internalized by children so that children are able to be empathetic and appreciate their friends" (R5-10 Jan 2025)

The role of teachers as mediators of social interaction is observed through teachers' efforts in organizing group learning activities that involve all students in an inclusive manner, encouraging interaction and cooperation between students, preventing exclusion of students with special needs, helping to resolve conflicts between students fairly and constructively, and guiding students in communicating and interacting positively in the classroom environment. The teacher stated:

> "To create continuous interaction, I set clear classroom rules at the beginning and made sure all students understood the importance of mutual respect. I also ensure that there is open communication between me and the students to create a sense of security in the classroom" (R2-10 Jan 2025)

> "I want to create strong bonds and increase student collaboration in participating in the classroom. I can do this by
> sometimes creating heterogeneous groups so that students are able to cooperate and collaborate with each other" (R6-10 Jan 2025)

The role of teachers as supporters of individual emotional needs is observed through giving attention and a personal approach to students with special needs, adjusting how to communicate according to the character and needs of students, providing motivation and emotional reinforcement consistently, teachers' efforts in creating a safe and emotionally comfortable classroom atmosphere, and teachers' concern for the emotional state of students during the learning process.

Furthermore, the role of teachers in implementing SEL can be seen in the image below:

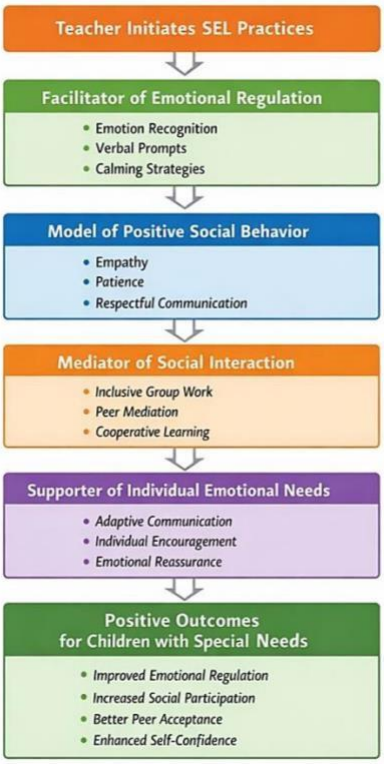


Fig. 2. Diagram of the role of teachers in SEL

Based on figure 2, it shows that the role of teachers in implementing Social-Emotional Learning in elementary schools starts from the teacher's initiative in implementing SEL practices. Furthermore, the role of teachers as facilitators of emotion regulation for students by helping to emotion recognition, verbal prompts, and calming strategies. The next flow shows that teachers function as positive social behavior models that are internalized by students with a sense of empathy, patience, and respectful communication. The next stage shows the role of teachers as mediators of social interaction that ensures the involvement and social acceptance of students with special needs by holding inclusive group work, peer mediation, and cooperative learning. This process is strengthened through individual emotional support that is responsive to the unique needs of each student through adaptive communication, individual encouragement, and emotional reassurance. This will ultimately have a positive effect on improving the social-emotional abilities and well-being of students with special needs as shown by improved emotional regulation, increased social participation, better peer acceptance, and enhanced self-confidence.

4. Discussion

Based on the results of the research, teachers clearly show good understanding and ability in implementing SEL. Teachers realize an understanding related to SEL to support children with special needs in inclusion classes with real roles. SEL is essential for the inclusion and acceptance of children with special needs [48], [49]. Teachers' understanding and implementation of SEL can significantly improve the social and academic outcomes of students with special needs [50], [51]. In the research, the role of teachers in SEL includes Facilitators of Emotional Regulation, Models of Positive Social Behavior, Mediators of Social Interaction, and Supporters of Individual Emotional Needs.

Teachers who act as facilitators of emotion regulation are characterized by teacher actions that can help students recognize the emotions they feel. Teachers who show empathy will be able to understand students' personal and social situations and respond with care and attention [52], [53]. Teachers who empathize with students can inspire and motivate students, thereby increasing achievement and satisfaction [54]. Teachers as facilitators will be able to provide guidance to students when they are angry or anxious, teach them strategies to calm down, and respond to students' emotional expressions with an empathetic and non-judgmental attitude. Teachers play an important role in recognizing the signs of anxiety by providing appropriate support [55], [56]. Teachers need to teach and instill stress

management techniques to help reduce stress and anxiety so as to restore students' focus [57], [58]. In addition, the role of teachers as facilitators is also seen in providing opportunities for students to express their feelings appropriately both verbally and nonverbally. The teacher's ability to manage one's own emotions will foster a positive emotional climate in the classroom [59]–[61]. The conscious and planned application of SEL practices makes teachers able to support the emotional regulation of students with special needs well in learning. Teachers must improve SEL teaching abilities to support students' basic psychological needs [62].

Teachers who are models of positive social behavior are characterized by the teacher's consistency to be empathetic to all students, the use of polite and respectful language in class interactions, and the patience of teachers in dealing with learning difficulties and the behavior of students with special needs. Teachers who show empathy and emotional support can affect students' social and emotional well-being [63]. Inclusive practices and supportive behavior of teachers are essential for the social and academic competence of students with special needs [64]. Positive teacher-student interaction and efforts to support students who are discriminated against can increase students' sense of community and motivation [65]. Teachers are also able to show an attitude of respect for differences and diversity in the classroom and provide examples of positive social behavior consistently. Teachers who are open and empathetic are more likely to be able to foster an inclusive environment [66]. Teachers who teach social values verbally and practically by providing real examples that students follow, thus proving the practice of SEL through the example of teachers are able to create a sustainable ecosystem and build an inclusive classroom. Teachers as role models for students must be able to show respect, empathy, and positive social interaction so that they can influence students to adopt similar behaviors [67], [68].

Teachers who act as mediators of social interaction are shown through teachers' efforts to organize group learning activities that involve all students in an inclusive manner, encourage interaction and cooperation between students, and prevent exclusion of students with special needs. Teachers can use different instruction to customize assignments and leverage peer support to ensure that all students can participate meaningfully [69]. Other studies reveal that teachers can guide students to find meaning and build shared knowledge through classroom discourse [70]. By becoming a mediator between students, teachers are able to carry out differentiated learning on social-emotional aspects. Responsive SELs can help create an equitable learning environment by considering individual differences and prioritizing empathy and social responsibility [71], [72]. Effective communication as well as student-tailored feedback are essential to creating a classroom environment that supports inclusivity [73]. In addition, teachers who are able to help resolve conflicts between students in a fair and constructive manner, as well as guide students in communicating and interacting positively in the classroom environment, will present the inclusive learning practices needed by students. Teachers who mediate conflicts fairly and constructively can easily create a positive classroom environment [74]. Teachers can foster an inclusive learning environment by embedding SEL practices into daily routines and learning [75], [76].

Teachers as supporters of individual emotional needs can be seen through teachers' concern in providing personal attention and approaches to students with special needs, adjusting how to communicate according to the character and needs of students, providing motivation and emotional reinforcement consistently, and being able to create a safe and emotionally comfortable classroom atmosphere. Teachers who provide consistent motivation and reinforcement will be able to create a classroom climate that supports and meets the emotional needs of students with special needs [77], [78]. A positive classroom climate is fostered by the support of teacher autonomy and a positive teacher-student relationship [79]. The role played by teachers can give an idea that it is important for teachers to meet the emotional needs of each student as a unique individual. By providing the emotional support needed by every student, adaptive and responsive SEL practice is able to accommodate both regular and special needs students. Effective SEL implementation requires acceptance from teachers, creative scheduling, ongoing evaluation, and ongoing leadership support [80]–[82].

The role of teachers in implementing Social-Emotional Learning in elementary schools starts from the teacher's initiative in implementing SEL practices. Teachers are responsible for the integration of SEL into students' daily experiences by building important life skills such as empathy, self-regulation, and responsible decision-making [83], [84]. Furthermore, the role of teachers as facilitators of emotion regulation for students by helping to emotion recognition, verbal prompts, and calming strategies.Teachers play an important role in the regulation of emotions to create a conducive learning environment [85]. The next flow shows that teachers function as positive social behavior models that

are internalized by students with a sense of empathy, patience, and respectful communication. Teachers' self-regulation and emotional intelligence are essential in fostering positive student-teacher relationships [86]. The next stage shows the role of teachers as mediators of social interaction that ensures the involvement and social acceptance of students with special needs by holding inclusive group work, peer mediation, and cooperative learning. For example, pairing students with special needs with proficient peers can create cooperation and support [69]. This process is strengthened through individual emotional support that is responsive to the unique needs of each student through adaptive communication, individual encouragement, and emotional reassurance. Providing emotional support is essential for the well-being of students with special needs [87], [88]. This will ultimately have a positive effect on improving the social-emotional abilities and welfare of students with special needs as shown by improved emotional regulation, increased social participation, better peer acceptance, and enhanced self-confidence. SEL encourages social inclusion and participation by improving social skills and empathy [48].

In this study, teachers are able to show different approaches according to the needs of students. SEL practice can be seen from teachers who are able to provide personal attention, adjust the way they communicate with students, provide both physical and emotional reinforcement, and are able to create a safe, comfortable, and inclusive classroom environment. So that this affects the condition of students. SEL can contribute to building CSN's confidence by creating an inclusive learning environment. Social-Emotional Learning (SEL) is recognized as an essential component of education that supports students' social, emotional, and academic development. Studies show that effective SEL programs not only improve social competencies such as cooperation, self-control, emotion regulation, and problem-solving [89], [90], but also strengthens interpersonal relationships and student decision-making [91]. So this study proves that learning for children with special needs is appropriate to be equated with regular students but can be adjusted to the needs of children through a SEL approach that is responsive to the needs of children.

5. Conclusion

This study shows that in social-emotional learning, teachers have an important role as Facilitators of Emotional Regulation, Models of Positive Social Behavior, Mediators of Social Interaction, and Supporters of Individual Emotional Needs. The results of observations and interviews show that the implementation of SEL strategies by teachers is able to increase the involvement of students with special needs in classroom activities and help them manage their emotions and interact with peers. The findings of the study also revealed that although SEL has been implemented, its implementation is still partial and highly dependent on teachers' initiatives, with the support of the school system and parental involvement not yet optimal. Theoretically, this study strengthens the understanding of the role of teachers in the implementation of SEL in the context of inclusive education, while practically the results of the research can be a reference for schools and educators in designing SEL strategies that are more adaptive and oriented to the individual needs of students with special needs. More broadly, the results of this study contribute to the achievement of SDGs 16 by affirming the strategic role of teachers in creating peaceful, fair, and inclusive elementary schools. This research is limited to one inclusive school in Surakarta City with a descriptive qualitative approach, so the findings cannot be generalized widely and require further research with a more diverse scope and methods.

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Using Pragmatic Language Profiles to Support Differential Diagnosis in Children with Developmental Language Disorder and Autistic Children

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Abstract

Developmental Language Disorder (DLD) and Autism share some common features in language development, often making the diagnostic distinction between the two disorders particularly challenging (Hage et al., 2022). These overlaps may lead to diagnostic ambiguity, affecting diagnostic accuracy (Andreou et al., 2022). Although pragmatic difficulties have been documented in both populations, significant differences between the two populations have been observed (Hage et al., 2022). The aim of the present study is to investigate whether the assessment of pragmatic skills could contribute to the differential diagnosis of Greek speaking autistic children and children with DLD. 25 children with DLD (Mean age=84.09 months) and 25 autistic children (Mean age=84.19 months), matched for chronological age and gender participated in the study. Pragmatic skills were examined using the Greek version of Children's Communication Checklist-2 (CCC-2, Bishop, 2003; Georgiou & Spanoudis, 2021). Specifically, the following scales of CCC-2 were used: Coherence, inappropriate initiation, stereotyped language, use of context, non-verbal communication, social relations and interests. Results showed significant differences across most measures with autistic children generally scoring lower than DLD children. The findings are examined in the context of diagnostic differentiation between the two populations. Pragmatic language, and in particular the pragmatic abilities in which differences are observed between the two groups, could potentially function as discriminative markers between the disorders. Consequently, the assessment of pragmatic skills, in combination with other diagnostic measures, may contribute to achieving more complete and accurate diagnoses.

Keywords: *Autism, DLD, pragmatic language*

1. Introduction

1.1 Autism Spectrum Disorder

Autism Spectrum Disorder (ASD) is characterized by persistent difficulties in social communication and social interaction across multiple contexts as well as restricted and repetitive (stereotypical) patterns of behaviour, interests and activities (APA, 2013). There is a high degree of heterogeneity in the language development of children with ASD. A percentage of children with ASD do not experience language difficulties, while other children are characterized as nonverbal, as they do not develop expressive or functional speech (Luyster & Lord, 2009; Norrelgen et al., 2014). Many children also experience delays in language development (Herlihy et al., 2015). Children with ASD and language difficulties mainly present difficulties in receptive speech and language comprehension (Volden et al., 2011; Zhou et al., 2018). In terms of pragmatic development, pragmatic abilities of children with ASD are significantly lower than those of their typically developing peers. In particular, weaknesses are already apparent in infancy, but as the child grows older, these weaknesses seem to become more intense (Papoudi & Kossyvaki, 2018). Furthermore, pragmatic difficulties are also observed in children with ASD without language difficulties (Baixauli-Fortea et al., 2019; Tager-Flusberg, 2006). More specifically, children with ASD present difficulties in conversational abilities, inference abilities and social reciprocity (Georgiou & Spanoudis, 2021; Lam, 2014).

1.2 Developmental Language Disorder

Developmental Language Disorder (DLD) is characterized by persistent deficits in language acquisition, as well as in understanding, production, and use of language (spoken or signed) (World Health Organization, 2019), causing significant limitations in the individual's ability to communicate. Language

difficulties are the main characteristic of children with DLD as language development is slower compared to that of their typically developing peers and these deficits are evident not only in childhood but also in adulthood (Davies et al., 2016).
Language difficulties are observed at all levels of language development and mainly in the production and comprehension of spoken language. In addition, difficulties are identified in reading skills and written language production (Andreou & Aslanoglou, 2022; Aslanoglou, 2023). Regarding pragmatic language, children with DLD also exhibit difficulties, which are probably more related to difficulties in structural language rather than to deficits in social knowledge (Andreou et al., 2025c; Davies et al., 2016). Pragmatic difficulties of children with DLD are mainly found in inference (Andrés-Roqueta & Katsos, 2020; Jones & Westermann, 2021), in conversational abilities (Andreou, Lymperopoulou & Aslanoglou, 2025a) and in understanding and using idiomatic language and figurative expressions (Vulchanova et al., 2019).

1.3 Commonalities and Differences between ASD and DLD in Pragmatic Language

DLD and ASD share some common features in language development, which often makes the differentiation between the two disorders particularly challenging (Hage et al., 2022). These overlaps may lead to diagnostic ambiguity or even confusion, affecting the accuracy and validity of the diagnosis (Andreou et al., 2022; Hage et al., 2022; Norbury et al., 2004). Although difficulties in pragmatic abilities have been documented in both individuals with ASD and DLD, pragmatic language is a linguistic level where significant differences between the two populations are evident (Hage et al., 2022; Schaeffer, 2018). The differences in pragmatic difficulties between the two populations mainly concern the nature of their deficits. Specifically, children with ASD have difficulties in pragmatic abilities related to both structural language (linguistic pragmatics) and Theory of Mind, such as social reciprocity (social pragmatics) (Andreou et al., 2025c; Andrés-Roqueta et al., 2017). In contrast, children with DLD have difficulties in pragmatic skills related to language (linguistic pragmatics), while pragmatic abilities related to Theory of Mind (social pragmatics) appear comparable to those of typically developing children, with any observed differences being minimal (Andreou et al., 2025c; Ferrara et al., 2020). Given these differences, the investigation of pragmatic skills could contribute substantially to the differential diagnosis of the two disorders by acting as a discriminative diagnostic marker (Andreou et al., 2022).
According to the above, the aim of the present study is to investigate whether the assessment of pragmatic skills could contribute to the differential diagnosis of Greek-speaking autistic children and children with DLD. Therefore, the following research hypotheses have been set:
1) It is expected that children with ASD will exhibit greater difficulties in pragmatic language abilities compared to children with DLD.
2) It is expected that children with ASD will exhibit greater difficulties in social reciprocity compared to children with DLD.

2. Method

2.1 Participants

The sample of the study consisted of 50 Greek-speaking students. More specifically, 25 children with ASD (mean age = 84.19; mean non-verbal intelligence= 89.80) and 25 children with DLD (mean age = 84.09; mean non-verbal intelligence = 88.20). Both groups comprised seventeen boys and eight girls and were matched on gender and chronological age. All participants attended either general or special schools in Greece and received individualized intervention programs, including speech and language therapy, occupational therapy, and special education support.
For the initial group allocation, the participants' official diagnoses issued by public state services, such as the Centers for Multidisciplinary Assessment, Counseling, and Support (KEDASY), were taken into consideration. Subsequently, all participants were administered the Greek version of the Raven's Coloured Progressive Matrices (Sideridis et al., 2015), and the Mean Length of Utterance -word (MLUw) was calculated (Rice et al., 2010).
The inclusion criteria for participation required that children be aged between 6 and 8 years old, have Greek as their first language and be monolingual, and have a non-verbal intelligence score of 85 or above as measured by the Greek version of the Raven's Coloured Progressive Matrices (Sideridis et al., 2015). In addition, participants were required to have an MLUw score of 4.0 or higher and no comorbid psychiatric or developmental disorders or sensory impairments, based on their official diagnoses. Participants in the ASD group had received an official diagnosis for Autism Spectrum

Disorder, High-Functioning Autism, or Atypical Autism, whereas participants in the DLD group had received an official diagnosis for language problems/deficits that compose the profile of DLD (Table 1).

Table 1. Means and Standard Deviations of Age, Non-verbal Intelligence and MLUw of the participants

	DLD[a]		ASD[b]	
	M	**SD**	**M**	**SD**
Age (months)	84.09	6.72	84.19	6.55
Non-verbal intelligence	88.20	4.54	89.80	4.20
MLUw[c]	4.37	0.09	5.79	0.82

[a] DLD=Developmental Language Disorder
[b] ASD= Autism Spectrum Disorder
[c] MLUw= Mean Length of Utterance (word)

2.2 Procedure

The study employed a non-probability sampling method, and specifically convenience sampling, due to the limited availability of the target populations (Etikan et al., 2016). Also, there was a predetermined time frame for the research, which precluded the use of random sampling techniques. Assessments were conducted individually by the researcher in a quiet setting at the school or educational center, typically across two or three sessions, with each child completing the full procedure in approximately 90 minutes. Non-verbal intelligence was evaluated using the Greek version of the Raven's Coloured Progressive Matrices (Sideridis et al., 2015), and language production was assessed by calculating the MLUw through spontaneous conversation.

2.3 Measures

The Greek version of Children's Communication Checklist-2 (Bishop, 2003; Georgiou & Spanoudis, 2021) was used in the research in order to evaluate pragmatic language abilities of the participants. It is the Greek adaptation of the Children's Communication Checklist-2 (CCC-2; Bishop, 2003) and includes 70 questions for children aged 4–16 years, completed by parents or teachers who have known the child for at least six months. The questions are divided into ten subscales that assess structural and pragmatic aspects of communication, specifically speech, syntax, semantics, coherence, inappropriate initiation, stereotypical language, use of context, nonverbal communication, social relationships, and interests.
In the current study, the subscales related to pragmatic skills were used. Specifically, the scales of Coherence, Inappropriate Initiation, Stereotypical Language, Use of Context, Nonverbal Communication, Social Relationships, and Interests were examined. The subscales Coherence, Inappropriate Initiation, Stereotypical Language, Use of Context, Nonverbal Communication constitute pragmatic language abilities. In addition, the last two subscales are combined to form the composite index of Social Reciprocity. Raters are asked to assess the frequency of specific linguistic, pragmatic, and social behaviors using a four-point scale ranging from "never or rarely" to "very often/always."

2.4 Data Analysis

Data analysis was conducted using IBM SPSS Statistics. Initially, descriptive statistics were calculated for all study variables. Group differences between children with ASD and children with DLD were examined using independent sample t-tests.

3. Results

Independent T-test analysis was performed to compare the two groups. Table 2 presents the descriptive data on the performance of the children in both groups on pragmatic language abilities, as well as the statistical significance between the groups on this measurement.
The analysis conducted to compare pragmatic abilities of children with ASD and those with DLD showed that there was a statistically significant difference (p<.001) in pragmatic language abilities between DLD

(*M*=28.44, *SD*=2.47) and ASD (*M*=24.08, *SD*=4.97) (Table 2). Table 3 presents the mean scores and between-group differences for each pragmatic language subscale of the CCC-2 (Bishop, 2003; Georgiou & Spanoudis, 2021).
The analysis comparing social reciprocity of children with ASD and children with DLD revealed that there was a statistically significant difference (*p*<.001) regarding social reciprocity between the groups (ASD *M*=-7.08, *SD*=9.35; DLD *M*=7.16, *SD*= 7.16) (Table 2). Table 3 presents the mean scores and between-group differences for each social reciprocity subscale of the CCC-2 (Bishop, 2003; Georgiou & Spanoudis, 2021).

Table 2. Performance of DLD and ASD groups in pragmatic language and in social reciprocity.

	ASD[a] (*n*=25)		**DLD[b] (*n*=25)**		***p***	**t-test**
	M	**SD**	**M**	**SD**		
Pragmatic Language	24.08	4.97	28.44	2.47	**<.001***	3.93
Social Reciprocity	-7.08	9.35	7.16	7.16	**<.001***	6.05

[a] ASD=Autism Spectrum Disorder
[b] DLD=Developmental Language Disorder
* p< .05

Table 3. Performance of DLD and ASD groups in subscales of CCC-2.

	ASD[a] (*n*=25)		**DLD[b] (*n*=25)**		***p***	**t-test**
	M	**SD**	**M**	**SD**		
Coherence	5.48	2.90	3.36	.81	**<.001***	-3.52
Inappropriate Initiation	5.36	.95	6.68	1.49	**<.001***	3.73
Stereotypical Language	5.88	1.45	7.76	1.59	**<.001***	4.37
Use of Context	5.08	1.26	6.92	2.20	**<.001***	3.64
Nonverbal Communication	2.28	1.14	3.72	.98	**<.001***	4.80
Social Relationships	.40	.96	1.20	2.10	.09	1.73
Interests	3.80	.87	5.88	2.05	**<.001***	4.68

[a] ASD=Autism Spectrum Disorder
[b] DLD=Developmental Language Disorder
* p< .05

4. Discussion

According to the first hypothesis, it is expected that children with ASD will exhibit greater difficulties in pragmatic language abilities compared to children with DLD. The results of the study indicated lower performance for children with ASD as compared to children with DLD in pragmatic language abilities and are consistent with previous research that compared the two populations on pragmatic language skills. More specifically, Hage et al. (2022) reported greater pragmatic difficulties in children with ASD in comparison to children with DLD, based on a questionnaire completed by teachers and parents. In addition, Ferrara et al. (2020) found lower performance in pragmatic language abilities for children with ASD in comparison to children with DLD using CCC-2 (Bishop, 2003). Finally, Andreou et al. (2025c) examined pragmatic language in Greek-speaking children with ASD and DLD and concluded that, although both groups demonstrated pragmatic impairments, pragmatic difficulties were more pronounced in children with ASD than in children with DLD. The first hypothesis was confirmed, reinforcing previous findings regarding pragmatic language in DLD and ASD.
The second hypothesis states that it is expected that children with ASD will exhibit greater difficulties in

social reciprocity (social relations and interests) compared to children with DLD. The findings of the present study showed that children with ASD scored significantly lower on the Social Reciprocity scale compared to children with DLD. This result was expected, as this particular scale of the CCC-2 (Bishop, 2003) has been documented as particularly sensitive in distinguishing between children with structural language difficulties and children whose pragmatic deficits exceed the level of their structural language skills, a characteristic often observed in the ASD population (Bishop & Baird, 2001; Norbury et al., 2004). The results are consistent with previous research findings, which indicate that children with ASD have greater difficulties in social reciprocity than children with DLD. In particular, de la Torre Carril et al. (2021) examining pragmatic language profiles of children with ASD and DLD using CCC-2 (Bishop, 2003) found that children with DLD did not present difficulties in social reciprocity, while the performance of children with ASD was significantly lower than that of children with DLD in this task. In addition, Ferrara et al. (2020) using also CCC-2 in these two populations reached similar results. Finally, Georgiou and Spanoudis (2021) in a study regarding Greek-speaking children with DLD and ASD found also lower performance for children with ASD as compared to children with DLD in social reciprocity. Thus, the results of the present study confirm the second research hypothesis and add further empirical data supporting the claim that children with ASD present more difficulties in social reciprocity as compared to children with DLD.

5. Conclusion

This study examined and compared the pragmatic profiles of children with ASD and children with DLD. The findings are consistent with previous research on the pragmatic abilities of the two populations. The differences identified in their pragmatic profile highlight pragmatic language as a possible factor in distinguishing the two disorders, underscoring the importance of its systematic assessment in the diagnostic process.

In particular, the differences observed in specific dimensions of pragmatic language support the view that, despite superficial similarities between ASD and DLD, the underlying linguistic and pragmatic deficits are not identical. In children with ASD, difficulties seem to be more related to social reciprocity and the use of language in a social context, while in children with DLD, limitations are mainly found in structural aspects of language (Andreou et al., 2025b).

Consequently, the integration of pragmatic skills assessment in combination with measures of structural language assessment may contribute significantly to diagnostic accuracy and clearer differentiation between the two disorders. At the same time, these findings have practical implications for the design of targeted interventions tailored to the specific communication profile of each group. More specifically, identifying distinct pragmatic language profiles in children with ASD and DLD may assist teachers, speech and language therapists, and special education professionals in identifying the specific communication needs of each population. Children with ASD may benefit from interventions that focus on social reciprocity, conversational skills, and the use of language in social context, while interventions for children with DLD may place emphasis on the development of structural language skills. Furthermore, the assessment of pragmatic abilities could support instructional planning and facilitate the selection of appropriate teaching strategies that address the specific communication needs of each group.

Finally, this study has certain limitations that should be taken into account when interpreting the findings. First, the relatively small sample size limits the ability to generalize the results to the broader population of children with ASD and DLD, as it may not fully reflect the heterogeneity that characterizes the two groups. Furthermore, the limited age range of the participants does not allow for the investigation of possible developmental differences in pragmatic abilities. Future research with larger and more age-diverse samples could offer more reliable and generalizable conclusions.

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The Use of Generative Artificial Intelligence in the Planning of Teaching Practices in Inclusive Special Education

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Abstract

The use of Artificial Intelligence (AI) can facilitate personalised activities tailored to students' specific needs, promoting greater engagement and meaningful learning. This paper presents a case study reporting on the application of generative AI in the planning of inclusive and personalised teaching practices for a 14-year-old boy diagnosed with an Intellectual Disability (ID), within the context of Specialised Educational Support (AEE), enrolled in year 8 of primary school at a state school in the interior of Rio Grande do Sul, Brazil. These actions were developed as part of the Pilot Project: Development of the EduEsp Pocket Guide prototype to assist in teaching practices with students with ID and/or Autism Spectrum Disorder (ASD), developed under the Institutional Programme for Introduction to Teaching (PIBID) at the Federal University of Santa Maria (UFSM-Brazil), in partnership with the Federal University of Paraná (UFPR-Brazil) and the Polytechnic Institute of Bragança (IPB-Portugal). Whilst preserving the anonymity of the student and the school, specific student information was used as a reference to develop targeted prompts that simulate learning situations and guide the creation of individualised activities and teaching strategies tailored to the student, thereby contributing to the development and implementation of Individualised Education Plans (IEPs). The results indicated significant potential to integrate AI and pedagogical planning to enhance teaching practices, reduce barriers to learning, and promote greater educational equity, thereby contributing to teacher training for work in technology-mediated, inclusive contexts. In addition, the study included a critical analysis of different available technologies, as well as the selection of consistent theoretical frameworks to guide the ethical and safe use of AI in education. This aspect has recently been corroborated by the Brazilian Artificial Intelligence Plan (BAIP), which helps define guidelines for the safe use of AI in education and encourages research to demonstrate its effectiveness.

Keywords: *Artificial intelligence, AI in Education, GenAI, EduEsp Pocket Guide, Intellectual Disability, Autism.*

1. Introduction

This article presents a case study within the framework of the "Pilot Project: Development of the EduEsp Pocket Guide Prototype", designed to support teaching practices with students with intellectual disabilities (ID) and/or autism spectrum disorder (ASD). The project was developed under the Institutional Program for Teaching Initiation Scholarships (PIBID), at the Federal University of Santa Maria (UFSM - Brazil), in partnership with the Federal University of Paraná (UFPR - Brazil) and the Polytechnic Institute of Bragança (IPB - Portugal). The EduEsp Pocket Guide prototype is based on AI and aims to assist teachers in personalising instruction for students with ID and/or ASD, ensuring inclusive and accessible teaching practices, which are increasingly in demand in a digital society characterised by inclusion and diversity.

The activities are carried out by students enrolled in the Special Education program at UFSM who are currently working in Specialised Educational Services (AEE) at a K-12 school in the municipality of Santa Maria, Rio Grande do Sul, Brazil. In short, they are near-future professionals.

The Institutional Program for Teaching Initiation Scholarships (PIBID) [1] is an initiative within the National Teacher Training Policy of Brazil's Ministry of Education (MEC). Administered by the Coordination for the Improvement of Higher Education Personnel (CAPES), which awards grants to Higher Education Institutions (HEIs) that select scholarship recipients for their approved subprojects, with the aim of fostering the initiation into teaching, contributing to the strengthening of teacher training at the higher education level and to the improvement of the quality of Brazilian public basic education. The program facilitates the integration of undergraduate students or academics into the daily life of

public schools, promoting collaboration between universities and basic education through supervised practical experiences [2].
Currently, the PIBID/UFSM Inclusive Special Education subproject operates through two centres, each with 24 teaching initiation scholarship recipients (students from Special Education programs), three supervising teachers (teachers from partner schools), and one coordinating teacher (a university professor). It carries out activities with specific objectives, in which students' involvement facilitates direct contact with the potential and challenges of planning inclusive and personalised pedagogical practices in the school context, as adapting activities to meet students' specific needs within a regular classroom setting has been a challenge for teachers. Thus, the report presented here addresses an initiative developed by Core 1 of the Inclusive Special Education subproject.
In the school context, the objective of developing the EduEsp Pocket Guide prototype is to create and implement an Artificial Intelligence (AI)-based prototype to assist teachers in decision-making and in personalising instruction for students with intellectual disabilities (ID) and/or autism spectrum disorder (ASD), ensuring inclusive, accessible, and efficient pedagogical practices. The proposal is justified by the need to serve an increasingly large population of students with learning difficulties, as confirmed by diagnoses, enrolled in elementary and secondary schools.
Brazilian law guarantees the right to education in an inclusive educational system for students with disabilities, autism spectrum disorder, and high abilities/giftedness, based on equal opportunities and without discrimination [3], [4]. According to the Statute of Persons with Disabilities, a person with a disability is defined as someone who has a long-term physical, mental, intellectual, or sensory impairment that, in interaction with one or more barriers, may hinder their full and effective participation in society on an equal footing with others [5].
In this context, special education is offered across all levels, stages, and modalities, with the aim of ensuring educational resources and services that support, complement, and supplement the schooling process.
Specialised Educational Services (AEE) should serve as a support to ensure conditions for access, participation, retention, and learning for students in the special education population within regular education. The objective of AEE is not to replace the traditional curriculum, but to complement the schooling of people with disabilities and/or supplement the schooling of highly skilled/gifted individuals, with a view to eliminating barriers to inclusion.
Professionals working in Special Education must have the necessary training to teach and undergo continuing education in inclusive education. To identify the students to be served, the law requires conducting case studies to inform the Specialised Educational Service Plan (PAEE) and the Individualised Educational Plan (PEI). The PAEE and PEI are mandatory individualized pedagogical documents designed to guide the work to be carried out in the general classroom; the work carried out within the scope of Specialized Educational Support (AEE); collaborative activities at the educational institution; and intersectoral coordination efforts [4], always taking into account, when necessary, the Brazilian Artificial Intelligence Plan (BAIP) [6] and the National Common Core Curriculum [7].
However, one of the challenges faced by teachers is developing accessible activities that do not distance students from the curricular proposals developed by the class. In this scenario, Generative Artificial Intelligence can serve as a tool to support instructional planning, assisting in the adaptation of texts, the simplification of language, the creation of visual materials, and the diversification of teaching strategies, avoiding the infantilization of content and materials that may occur when using these technologies [8] and adhering to Universal Design for Learning (UDL) [9].
Generative Artificial Intelligence (GenAI) is the branch of AI focused on creating new content—texts, images, audio, videos, and code-based on patterns learned from large training datasets [13], [15]. Unlike traditional systems, GenAI tools rely on Large Language Models (LLMs), which operate probabilistically, predicting sequences of words or pixels based on statistical correlations [1]. This architecture underpins tools such as ChatGPT, Gemini, Copilot, Claude, DALL-E, Suno, and Pictory, among others, which are gradually being incorporated into everyday educational practice.
In the field of education, GenAI has established itself as a resource to support the personalization of teaching, curriculum adaptation, and the development of accessible instructional materials [1], [13], [16], with significant potential for Inclusive Special Education by generating activities aligned with the Individualized Education Plan (IEP) and tailored to students' cognitive characteristics, interests, and age groups. However, generative models operate through statistical inference and can produce plausible yet inaccurate or biased responses, which is why ethical, critical, and teacher-mediated use is an indispensable condition [1], [16].
The BAIP, launched in 2025, aims to guide the development, use, and regulation of AI in Brazil with a focus on addressing major national, social, economic, environmental, and cultural challenges, in order

to ensure security and individual and collective rights, social inclusion, the defense of democracy, information integrity, the protection of labour and workers, national sovereignty, and the nation's sustainable economic development [6].
Regarding the positive impacts and challenges of AI in inclusive education, studies published between 2021 and 2024 highlight that AI improves accessibility by providing adapted materials and helps alleviate educators' administrative burden, allowing them to prioritise pedagogical guidance. As for the challenges, there remain shortages of AI training, inadequate infrastructure, and ethical concerns related to privacy and equitable access to technology [12].
The effectiveness of GenAI tools depends on the quality of the prompts used in interacting with the model. Prompt Engineering is defined as the systematic process of designing, refining, and evaluating natural language instructions to obtain more accurate, relevant, and pedagogically aligned responses from LLMs [14], [17]. According to the literature, a well-structured prompt includes four central elements – instruction, context, examples, and constraints [17] – and can employ techniques such as zero-shot, few-shot, role prompting, and chain-of-thought prompting [14].
In the educational context, it is through Prompt Engineering that the teacher exercises their pedagogical authorship over the product generated by AI [13], [14]. In Inclusive Special Education, describing the student's skills, potential, interests, and learning barriers in the prompt guides the AI to produce materials aligned with the Individualised Education Plan (IEP), respecting the age group and avoiding infantilization. It is, therefore, a new teaching competency, linked to the critical evaluation of the generated outputs and adherence to ethical principles regarding privacy, equitable access, and respect for diversity [14], [15].

2. Methodology

The scientific methodology is a rigorous and systematic approach that serves as the basis for producing reliable, verifiable knowledge, grounded in precise and demonstrable findings. Consequently, we present the participants, the location, the instruments and the procedures adopted in a case study.
Participants: The study involved students from the Special Education course at UFSM, together with their supervising lecturers and project partners. For the case study, based on the observations, a student was selected (here referred to as Rafael) to preserve his anonymity. He is a 14-year-old adolescent diagnosed with an Intellectual Disability (ID), enrolled in the 8th year of primary school. Rafael demonstrates a high degree of independence in his home life, but experiences difficulties with reading, writing, comprehension and social interaction. Specifically:

- Communication: speaks softly, is shy, uses gestures;
- Reading/writing: recognises letters and numbers up to 20;
- Socialisation: keeps to himself at break time, interacts in small groups in the Multifunctional Resource Room (MRR);
- Independence: takes care of his own meals, personal hygiene and clothing.

Location: The activities were carried out at a primary and secondary school located in a socially vulnerable area of the municipality of Santa Maria, Rio Grande do Sul, Brazil. Within the school, the activities took place in two main areas: the Multifunctional Resource Room (SRM), where Specialised Educational Support (AEE) is provided, and the mainstream classroom during lessons in specific subjects.
Instruments: For the functional assessment of the student, the SIS-A (Support Intensity Scale – Adult Version, currently in the final stages of validation in the Brazilian context) was used. To develop the pedagogical activities, a comparative analysis was conducted of various available Artificial Intelligence tools, namely ChatGPT, Gemini, Copilot, NotebookLM, Para Casa Inclusivo, and Suno, to identify which one(s) were most suitable for the student's educational context. Interaction with these tools occurred through the creation of targeted prompts that simulated learning situations and guided the development of individualised activities and teaching strategies tailored to the student.
The following are used for assessment and monitoring: quarterly descriptive reports; a portfolio with photographs and written records; interdisciplinary teaching meetings; participatory class councils; and, where possible, reassessment using SIS-A.
Procedure: The activities began in October 2024. The students attended the school for two sessions per week and, during one of those sessions, participated in study and planning meetings at the university. Each week, the activities carried out at the school were discussed in meetings with the supervising teachers and project partners. Initially, observations of students were carried out in the AEE and SRM, and monitoring took place in the mainstream classroom during lessons in specific subjects.

During the observations, the students' skills, potential, difficulties and needs were considered. Following the initial assessment period, a case study was selected from which Rafael's profile was created. Concurrently with the observation phase and the collection of information about the student, studies were carried out at the University, involving the selection of reliable theoretical sources to provide a foundation, the comparison of available technologies, and the choice of the most appropriate Artificial Intelligence tool to support the personalisation of teaching and the making of more assertive pedagogical decisions for the case. Based on Rafael's profile, the following objectives were established: to ensure active and meaningful participation in learning activities covering the content of the Brazilian National Common Core Curriculum (BNCC), delivered in mainstream classrooms [7]; to promote communicative and socio-emotional skills; to foster autonomy and self-esteem; and to implement the principles of the Individualised Educational Plan (IEP) and, where possible, to develop Universal Design for Learning (UDL). The most frequently used methodological strategies were structured, pre-planned routines; the use of concrete materials (bottle caps, images, games); small-group activities, always mediated; and oral, practical, and descriptive assessments. Whilst preserving the anonymity of the student and the school, specific information about the student was used as a reference for developing targeted prompts that simulate learning situations and guide the creation of individualised activities and pedagogical strategies tailored to Rafael. The design of these activities was discussed at length by the team and then implemented at the school with the student.

3. Results

In the results section, we will present the prompts and outputs generated by GenAI. Next, two detailed examples are presented: Portuguese Language (Table 2) and Science (Table 3), which show the planned subjects, proposed or to-be-proposed topics, pedagogical objectives, requested adaptations, and the GenAI used.

Table 1. Description of the plan for using GenAI in the teaching activities devised by the team.

Subject	Theme/Proposal	Objective	Adaptation	AI tool
Portuguese	Text comprehension	Oral and visual comprehension	Text with pictograms + read-aloud	Chat GPT, Gemini
Mathematics	Decimal numbers	Understanding quantities up to 100	Bottle caps + visual aids	DALL-E, ChatGPT
Science	The water cycle	Understanding and distinguishing the physical and chemical states of water	Real objects and music	DALL-E, Canva, Voicemod
History	The culture of Brazil's indigenous peoples	Respect for cultural diversity	Illustrated comic strips	Pictory, Lumen5
Physical Education	Motor skills	Body and spatial awareness	Visual and verbal activities	Soundrw, Synthesia

To illustrate the activities, the planned practices for the Portuguese and science courses will be presented. As an example of an activity for the Portuguese Language course (Table 2), the objective was defined as oral and visual comprehension, with a focus on text interpretation. For Activity 1, the following sequence of prompts was devised, which generated the following outputs.

Table 2. Sequence of prompts and outputs for creating an adapted activity for Portuguese.

Prompt 1
"Write an educational text in Portuguese for Year 8 pupils, using simple, short and straightforward sentences. The topic is 'Separating Organic and Recyclable Waste'. The text should explain: what organic waste is, what recyclable waste is, examples of each, and how separating them helps the city and the environment. The text should be no more than 150 words and use language that is accessible to students with intellectual disabilities."
Answer 1
"Title: Managing Waste: Organic and Recyclable

Every day, we produce waste at home and at school. This waste can be divided into two main types: organic and recyclable. Organic waste comes from food scraps, such as fruit and vegetable peelings and bread crusts. This waste can be turned into compost for plants. Recyclable waste consists of materials such as plastic bottles, paper, tins and glass. When recycled, they can be turned into new objects and help reduce pollution. Sorting waste is an act of caring for the environment. When we put waste in the right place, we help keep the city cleaner and contribute to the health of nature and people."

Prompt 2

"Rewrite the text using emojis as pictograms to represent key words. The text should be simple, with short sentences, and accessible to a 14-year-old student with an intellectual disability.
Topic: Waste sorting.
Use pictograms for: rubbish, organic waste (🍌 🥕 📦), recyclable (♻️ 📰 🍾), city (🏙️), nature (🌳), people (👨‍👩‍👧‍👦)."

Answer 2

"Title: 🌍 ♻️ Managing Waste
📦 We produce waste every day.
👉 This waste can be of two types:
1️⃣ Organic waste 🍌 🥕 📦
➡️ Food scraps (peels, fruit, bread).
➡️ Can be turned into 🌱 compost for plants.
2️⃣ Recyclable Waste 📰 🍾 ♻️
➡️ Paper, plastic bottles, tins, glass.
➡️ Can be turned into new objects.
✨ Sorting your rubbish helps:
✔️ Keep the city clean 🏙️
✔️ Look after nature 🌳
✔️ Improve people's lives 👨‍👩‍👧‍👦"

Prompt 3

"Create a series of nine images in a children's educational style, using bright colours and simple lines, in Portuguese, on the theme of 'Waste Management'. Each panel should feature a short, clear sentence and an illustrative pictogram.
Panel 1: 'We produce waste every day' (a boy throwing rubbish into a bin).
Panel 2: 'Organic Waste' (banana peel, carrot, bread).
Panel 3: 'It can become compost' (plant growing).
Panel 4: 'Recyclable Waste' (bottle, paper, tin).
Panel 5: 'Sorting rubbish helps' (city and trees) and "Keeping the city clean" (clean city) (green tree).
Panel 6: 'Keeping the city clean' and 'Caring for nature' (three smiling children)."

Answer 3 (English version and original Portuguese version)





Images created and translated in ChatGPT

For the science module (Table 3), the aim was to understand and distinguish the physical and chemical states of water; in this activity, the goal was to use real images for matching exercises and music with a rhythm of the student's choice.

Table 3. Sequence of prompts and outputs for designing an adapted Science activity.

<table>
<tr><th colspan="4">Prompt 1 for image pairing (Gemini)</th></tr>
<tr><td colspan="4">"Create six high-quality, photorealistic images, maintaining a consistent visual style. Each image must depict one of the three states of water (solid, liquid, gaseous), with two examples for each state: one from everyday life and one from nature. The word corresponding to the state of water ('SOLID', 'LIQUID', 'GAS') must be displayed in all images using the same font style.
For the Solid state: An ice cube and a frozen winter mountain landscape
For the Liquid state: A river in the rain with visible raindrops in the water and in the air, and a clear glass filled with water with condensation droplets on the outside, without ice
For the Gaseous state: A kettle on the hob, emitting a large amount of dense steam, and a mountainous valley covered in thick fog or low-lying clouds.</td></tr>
<tr><th colspan="4">Answer 1</th></tr>
<tr><td colspan="4"> 
</td></tr>
<tr><td>SOLID</td><td>GASEOUS</td><td>LIQUID</td><td>LIQUID</td><td>GASEOUS</td></tr>
<tr><th colspan="4">Prompt 2 for children's pop music (Suno)</th></tr>
<tr><td colspan="4">Children's pop song (1–1.5 mins) about the water cycle and the states of water. The lyrics explain that water is everywhere and changes form! Liquid, solid, gas. Links: evaporation, condensation, precipitation. Chorus: continuous transformation. Young, clear, enthusiastic voice; children's choir. Aim: to memorise and understand the water cycle. In Brazilian Portuguese.</td></tr>
<tr><th colspan="4">Answer 2 - Song lyrics: The Water Cycle</th></tr>
<tr><td>[Verso 1]
Água no copo
Água no rio
Cai do céu
Faz um desafio
Chove na terra
Escorre no chão
O ciclo começa
Presta atenção

[Pré-refrão]
Evapora no calor do sol
Sobe ao céu
Vira um lençol

[Refrão]
Transformação contínua
Sem parar
Água é mágica
Sempre a mudar
De líquido a vapor
Vai condensar
Volta em chuva
Pra recomeçar</td><td>[Verse 1]
Water in a glass
Water in a river
Falls from the sky
It's a challenge
It rains on the earth
Runs down the ground
The cycle begins
Pay attention

[Pre-chorus]
Evaporates in sun's heat
Rises to the sky
Turns into a blanket

[Chorus]
Constant transformation
Non-stop
Water is magic
Always changing
From liquid to vapour
It condenses
Returns as rain
To start all over again</td><td>[Verso 2]
Lá nas montanhas
O gelo a brilhar
Neve que cai
Sólido a formar
Vapor da chaleira
Nuvem no ar
Neblina na manhã
Vem nos abraçar

[Pré-refrão]
Condensa lá no alto
Vira gota a cair
Precipita de novo
Pra vida surgir

[Refrão]
Transformação contínua
Sem parar
Água é mágica
Sempre a mudar
De líquido a vapor
Vai condensar
Volta em chuva
Pra recomeçar</td><td>[Verse 2]
Up in the mountains
The ice glistens
Snow falls
Solid forms
Steam from the kettle
Clouds in the air
Morning mist
Come and embrace us

[Pre-chorus]
It condenses up above
Becomes a falling drop
Falls once more
For life to emerge

[Chorus]
Constant transformation
Non-stop
Water is magic
Always changing
From liquid to vapour
It condenses
Returns as rain
To begin anew</td></tr>
</table>

4. Discussion

The use of prompts based on systematic observations of the student enables the creation of activities that are more accessible and tailored to the adolescent's specific needs, thereby encouraging the adolescent's participation and learning. This process aligns with the view that working with students with intellectual disabilities requires individualised, collaborative planning that is grounded in the student's reality and built around clear goals. The detailed description of skills, potential, and learning barriers in the prompts transformed pedagogical observation into direct input for the personalisation of teaching, a function that, according to Arruda (2024), constitutes one of the most promising contributions of Generative AI to teaching practice [1].

In this regard, it was possible to observe that AI tools complement one another, as exemplified by the creation of comic strips, where prompts needed to be adjusted several times to ensure they were age-appropriate for the student to avoid infantilising the proposed activities. The iterative process of refining commands to avoid infantilising the activities corresponds to what Röhe and Santaella (2023) characterise as an inherent condition of GenAI use, particularly in image generation tasks, which require progressive refinement and multiple attempts at adjustment [13]. Such vigilance is pedagogically fundamental: Camargo (2022) warns that treating adolescents with intellectual disabilities as children, by proposing activities outside their age-appropriate context, leads to demotivation and compromises the full development of their potential [8].

Activities such as comics, word searches, crosswords, and quizzes, recommended by AI tools as teaching strategies, have proven particularly engaging and effective for students with reading difficulties, aiding their comprehension of the content. The effectiveness observed with the use of comic strips, word searches, crosswords and quizzes is consistent with the studies by Lima, Sena and Serra (2024); Magnago and Nunes (2024), which demonstrate that playful resources and gamification elements contribute to the cognitive, social and linguistic development of students with intellectual disabilities, enhancing intrinsic motivation and promoting personalised learning [10], [11].

The diversification of teaching strategies promotes student engagement and their participation in the proposed activities. The activities planned based on the content that mainstream classroom teachers are working on – and thus tailored to the class's real-world context, where all students can participate – align with the most current principles of inclusive education. The diversification of teaching strategies aligns, for example, with the principles of Universal Design for Learning (UDL) – a curricular approach that advocates multiple forms of presentation, expression and engagement [9]. From this perspective, the use of GenAI to generate variations of the same content (pictograms, audio, images, video and simplified text) serves as an operational resource for implementing UDL in teaching practice.

Final Remarks

Artificial Intelligence tools can be used as allies in inclusive education, enabling teachers to analyse pedagogical data, identify learning patterns, suggest curricular adaptations, recommend personalised strategies for each student, and draw up Individualised Education Plans, thereby enhancing active participation and meaningful learning. The creation of personas with AI supports undergraduate students in their initial training when discussing inclusive strategies to cater to students with intellectual disabilities (ID) and/or autism spectrum disorder (ASD), as well as classes with diverse profiles.

Furthermore, the use of AI in pedagogical planning has demonstrated potential to optimise time spent developing materials and activities, allowing teachers to prioritise more meaningful and contextualised practices for students, particularly those in special education. The activities produced with the support of digital tools proved to be more accessible, visually appealing and aligned with students' interests, fostering greater engagement, participation and autonomy.

Thus, integrating Artificial Intelligence and pedagogical planning can improve the quality of education for students with ID and ASD, reducing educational inequality through personalised learning, with teachers better equipped to work with technology and inclusion. However, it should be emphasised that it is necessary to respect the ethical principles governing the use of AI in the creation of accessible teaching materials, considering students' real needs and avoiding the production of childish materials, especially for adolescents and young people in special education.

It should be acknowledged that this study has certain limitations inherent to its single-case design, which constrain the generalisability of its findings to other students and contexts. Moreover, whilst the activities were observed to increase engagement and participation, no systematic outcome data or standardised indicators of student responses were collected, which limits the extent to which improvements in learning can be directly attributed to the use of GenAI-supported materials. The iterative refinement of prompts,

particularly for image generation, also warrants further documentation, as the number of adjustments required, the nature of the changes made, and the criteria guiding each refinement step were not systematically recorded. Future studies should therefore incorporate clearer protocols for tracking prompt iterations and for measuring student outcomes over time. Finally, although ethical considerations regarding privacy, data protection, and the avoidance of infantilising content were addressed throughout the project, a more in-depth critical discussion of the risks associated with GenAI use in inclusive education – such as algorithmic bias, over-reliance on AI-generated content, and the potential erosion of teacher judgement – remains an important avenue for future work.

Whilst this pilot case study focused mainly on representation and engagement, future developments of the EduEsp Pocket Guide could also explore GenAI's role in supporting Action and Expression – for instance, enabling Rafael to demonstrate learning through audio recordings, AI-transcribed dictation, or simple multimedia productions. Future iterations should also gather qualitative feedback from PIBID undergraduates on how this process shaped their own pedagogical reasoning and professional development.

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Learning is For Everyone (LiFE): Paving the Pathway for Inclusive Education for Children with Disabilities

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Abstract

Children with disabilities remain among the most excluded learners globally. Despite growing policy commitments to inclusive education, persistent barriers related to stigma, inaccessible environments, rigid curricula, limited teacher preparation, and insufficient data systems continue to prevent their meaningful participation and learning. The Learning is For Everyone (LiFE) research initiative, led by UNICEF Innocenti in partnership with UNICEF country offices, offered a comprehensive mixed-methods, system-level analysis of inclusive education for children with disabilities, aiming to identify the challenges countries face in making their education systems more inclusive. The research was conducted in seven countries: Cambodia, Djibouti, Kyrgyzstan, Mozambique, Nepal, Niger, and Paraguay. Drawing on quantitative and qualitative primary data from teachers, head teachers, district officials, parents, and children with and without disabilities; alongside secondary analysis of Programme for International Student Assessment – Development (PISA-D) 2018 and Multiple Indicator Cluster Survey (MICS) 6 data, and a targeted global literature review, this paper synthesizes the key findings and evidence-based policy recommendations organized around three interconnected action areas: Recognize, Reform, and Resource. Findings reveal that exclusion is not inevitable but often reflective of systemic gaps that can be addressed. The paper concludes with a call for sustained political will and financial investment, coordinated intersectoral action, and the recognition of diversity as a strength that benefits all learners.

Keywords: *inclusive education, children with disabilities, Universal Design for Learning, low-and middle-income countries*

1. Introduction

Children with disabilities were half as likely to attend school as their peers without disabilities, despite education being a fundamental right for every child [1] [2]. Even when enrolled, they face persistent barriers to learning. Data from 2021 showed that children with disabilities are 42 per cent less likely to develop foundational literacy and numeracy skills. These figures underscore that access alone is insufficient. Education systems must enable meaningful participation and learning for every child, including children with disabilities who represent 10 per cent of children aged 0-17 globally [3].

Providing meaningful learning opportunities for all children requires a systemic shift towards inclusive education. Inclusive education, as defined in General Comment No. 4 of the Convention on the Rights of Persons with Disabilities (CRPD), involves comprehensive reforms to content, pedagogy, structures, and strategies, aiming to ensure responsive, participatory, and supportive learning environments for all [4]. This vision aligns with Sustainable Development Goal 4, which affirms the global commitment to inclusive and equitable quality education [5].

Evidence consistently shows that inclusive settings benefit all learners. They boost the self-efficacy, social skills, and academic performance of students with disabilities, while also supporting neurodivergent learners and those with invisible or uncertified needs through more responsive instruction [6]. Students without disabilities benefit as well, gaining problem-solving, interpersonal, and socioemotional skills from learning alongside diverse peers [7], yet these gains are often limited by inadequate financing, system capacity, teacher preparation, and persistent stigma.

The Learning is For Everyone (LiFE) research initiative, led by UNICEF Office of Strategy and Evidence–Innocenti in partnership with UNICEF country offices and ministries of education in seven countries (Cambodia, Djibouti, Kyrgyzstan, Mozambique, Nepal, Niger, and Paraguay), was designed to generate system-level evidence to address these challenges. Guided by the Education Sector Analysis (ESA) volume 3 guidelines, the research examined how policies, school structures, pedagogy, data systems, and accountability mechanisms interact to enable or constrain the implementation of inclusive education

[7]. This approach allowed an emphasis on the principle that inclusive education should be a core component of an education system, requiring systemic reform rather than being treated as an add-on.
This paper presents a synthesis of the findings and policy recommendations, structured around three action areas derived from the research: Recognize, Reform, and Resource. It argues that governments must **recognize** children with disabilities as rights-holders and ensure their inclusion is visible and valued through improved understanding and documentation of disability. It calls for **reform** across education systems so that policies, structures, and professional practices respond to learner diversity rather than relying on adhoc efforts. Finally, it emphasizes the need to **resource** inclusive education through sustained investments in accessible environments, materials, and human capacity to translate commitments into meaningful change

2. Methodology

The main goal of the LiFE research was to generate evidence on the status of inclusive education for children with disabilities across pre-primary, primary, and secondary levels, and to provide evidence-based policy recommendations relevant at both country and global levels. The study followed a mixed-methods design, combining primary and secondary data analysis, to answer three core research questions about the barriers children with disabilitiesn face, the system-level constraints shaping provision, and the opportunities that can be scaled to strengthen inclusive education.
The research was anchored in the inclusive education framework in the ESA Volume 3, which examines disability-inclusive education systems across four dimensions: supply (teachers, infrastructure, learning materials), quality (curriculum, assessment, learning support), demand (attitudes, costs, perceived benefits), and the enabling environment (laws, policies, data, finance). This framework informed all stages of the research, from design to interpretation of data.

2.1 Instruments and Data Analysis

The paper used a comprehensive mixed-methods design drawing on three data sources**: (i) a targeted global literature review** of recent academic and policy work on disability-inclusive education; **(ii) country-level primary research** involving digital surveys with teachers, head teachers, and district officials in six countries, along with interviews and focus groups with children aged 10–16 (with and without disabilities), their parents, and teachers; **(iii) and secondary analysis** of international datasets, including PISA for Development (2018), PISA 2022 teacher data from low- and middle-income countries, and existing analyses of the Child Functioning Module from MICS Round 6.
Ethical approval was received for the country-level research from an Institutional Review Board, and ethical standards were applied throughout the study, using age-appropriate assent to ensure children's informed participation. Accessibility was prioritized through accommodations such as sign language interpretation and simplified materials to support children's comfort and well-being.

2.2 Limitations

Certain questionnaire items were adapted to local contexts, reducing the potential for direct cross-country comparison. Response rates varied across countries and participant groups, affecting representativeness. Although accommodations were provided for children with disabilities, additional adjustments to protocols were required at times, and translation from local languages may have led to a loss of nuance. For the secondary data analysis, access to datasets varied, and definitions of disability differed across sources, requiring careful interpretation.

3. Findings

3.1 Recognize: Making Disability Understood and Valued

Advancing inclusive education requires recognizing children with disabilities as rights-holders, learners, and active contributors. This begins with shifting how disability is understood, measured, and addressed.

Attitudes and perceptions of disability
LiFE evidence shows that the understanding of disability varies widely across countries and stakeholders, shaping attitudes and influencing the direction of inclusive education reforms. Policy frameworks range from medical-model approaches, as seen in Cambodia and Kyrgyzstan, to more

social-model orientations in Djibouti, Mozambique, Paraguay, and Nepal—differences that affect whether systems prioritize segregation or inclusive practices. Across all countries, participants' perceptions were often medicalized, with disability viewed as a deficit, especially for invisible disabilities. Attitudes among parents, teachers, and children were mixed: many expressed support for inclusion, yet misconceptions, stigma, and uncertainty persisted. These perceptions have concrete implications, reinforcing expectations of separate provision and limiting pedagogical adaptation in mainstream schools. Some countries, such as Djibouti and Nepal, have begun fostering more positive attitudes through structured interactions between children with and without disabilities, helping challenge stereotypes and build more inclusive school cultures.

"Boys with disabilities are people just like us; they are not different from us—they are beautiful human beings." (Child without disability, Primary school, Paraguay)

Identification systems

Consistent with global trends, LiFE research highlighted a lack of systematic protocols for identifying barriers to learning and participation. Screening tools exist in most countries, but tools designed to identify functional barriers within classrooms are largely absent. Many children remain unidentified, particularly those with invisible disabilities. Particularly, screening tools remain widely used but face persistent limitations, especially in Low- and Middle-Income Countries (LMICs), where many children are still not identified. Coverage is uneven because tools are often not culturally or contextually adapted, and "culture-free" instruments may miss context-specific developmental issues [8]. Evidence from systematic reviews shows that screening tools tend to be less effective outside their original linguistic or cultural settings, and culturally sensitive tools for LMICs remain scarce [9].

LiFE data indicated that over 70% of trained teachers in Djibouti, Kyrgyzstan, Mozambique, Nepal, and Paraguay reported that their training helped them identify indicators of potential disability (Figure 1). Nonetheless, clear referral pathways linking identification to support within and beyond school are still needed to ensure timely provision of services.

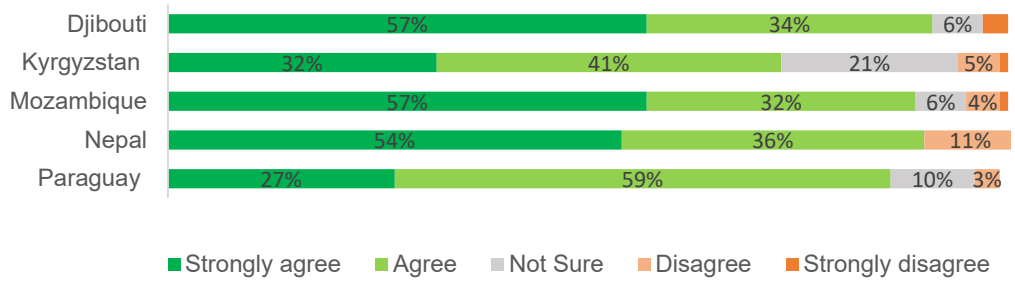


Fig. 1. Teacher's agreement on how training courses have helped them to identify indicators of a potential disability or learning difficulty

Source: Author's elaboration, based on LiFE teacher surveys.

Disability data systems

LiFE evidence revealed that while most countries collect some disability information, their systems still rely heavily on medical classifications, and only a few capture functional difficulties—limiting their ability to plan inclusive support. Although six of the seven countries use Washington Group (WG) questions in national censuses, integration into Education Management Information Systems (EMIS) was less common, with only Mozambique and Nepal adopting functional approaches in school-level data. These findings mirror global patterns: many regions lack unified disability definitions and rely on medical models, though promising initiatives—such as MICS-6 comparable data, the adoption of WG tools in East and Southern Africa, and recent efforts to make large-scale assessments more accessible [10]—show a broader shift toward functional, rights-based data systems that can strengthen national reforms.

3.2 Reform: Transforming Education Systems

Inclusive education requires system-wide change; LiFE evidence shows persistent gaps but also highlighted positive dispersed practices showing signs that progress is achievable.

Access and school placement

LiFE findings showed that children with disabilities faced persistent barriers to accessing and thriving in mainstream education, including reliance on special schools driven by concerns about capacity, safety,

and resources in regular schools, as well as mixed attitudes from teachers and parents shaped by system constraints. These patterns mirror global evidence from PISA-D and MICS, which consistently document lower attendance among children with disabilities, higher rates of exclusion, weaker learning outcomes, and gender-specific barriers such as inadequate WASH facilities for girls with disabilities. LiFE qualitative data also revealed that some families perceived special schools as safer due to less incidents of bullying, while examples from Mozambique highlight how strong school leadership and community partnerships can foster more inclusive environments. International evidence, such as resource centre models in Ethiopia and Paraguay, highlights how mainstream systems can benefit from the expertise of special schools, the knowledge of specialised professionals, and the use of accessible teaching and learning materials, to build their capacity on how to support children with disabilities.

Inclusive teaching practices & teacher training

Despite limited formal training, many teachers across LiFE countries reported intuitively applying inclusive practices, drawing on principles of frameworks such as Universal Design for Learning (UDL), collaborative learning, and differentiated instruction, by repeating key information, offering individual support, using real-life examples, and adapting classroom seating arrangements. In Nepal, 93% of teachers reported seating students based on individual needs. However, in most LiFE countries fewer than 20% of teachers received formal training in disability-inclusive education (Figure 2). Existing training was frequently short, irregular, and theoretical. Large class sizes, rigid curricula, and limited resources were cited as barriers to implementing inclusive approaches effectively. The OECD TALIS 2024 survey confirms this is a global challenge: 1 in 4 teachers across OECD countries reported needing additional training in teaching students with special education needs [11].

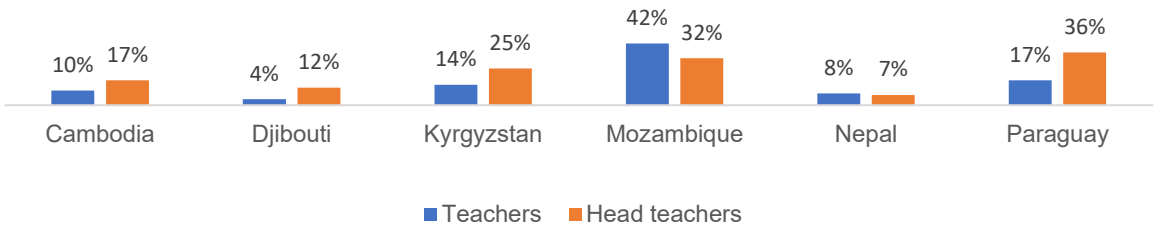


Fig. 2. Percentage of teachers and head teachers that reported receiving training in disability-inclusive education, by country

Source: Author's elaboration, based on LiFE head teacher and teacher surveys.

Assessment for all

LiFE evidence showed that although many countries have adopted inclusive education policies, inclusive assessment strategies were lagging, with most countries missing clear frameworks or applying them inconsistently. This often meant children with disabilities were assessed in ways that did not meet their needs. Teachers and students across LiFE countries reported that accommodations were rare and often limited to extra time, which was not always effective. Nonetheless, more meaningful adaptations were also observed, including sign language interpretation, Braille versions of tests, scribes, and quieter testing environments, indicating that good practices exist but require systematisation and scaling. These findings align with global research, which shows that inclusive assessment is conceptually underdeveloped, overly focused on categorisation, and rarely designed to support diverse learners [12].

3.3 Resource: Investing in Inclusion

Achieving inclusive education requires sustained investment in both material and human resources. Without adequate resourcing, policy commitments cannot be translated into practice.

Physical accessibility

School infrastructure and transportation were major barriers to school access across all LiFE countries. Families of children with disabilities reported lacking accessible and affordable transport, with some parents, predominantly mothers, having to leave their employment to accompany their children to school or stay with them during the day to support them with mobility or hygiene activities. Within schools, the absence of ramps, narrow doorways, overcrowded classrooms, and inaccessible WASH facilities restricted mobility and participation. Head teacher surveys confirmed limited availability of essential accessibility features, especially tactile floor signals and accessible toilets (Figure 3).

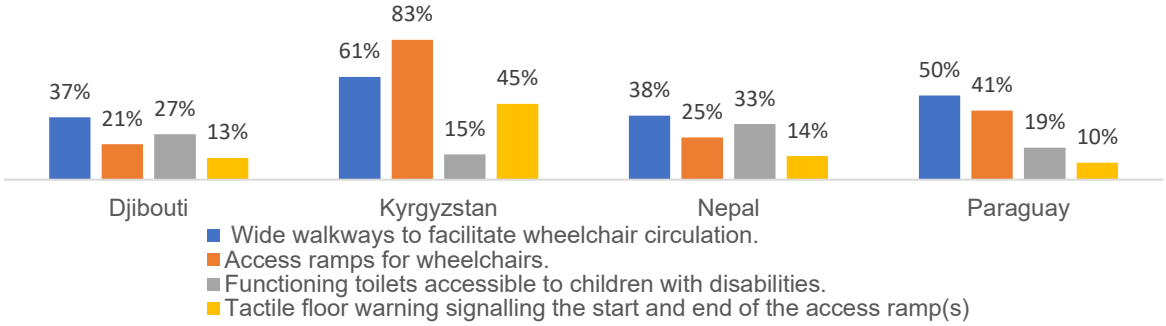


Fig. 3. Percentage of head teachers who reported the following accessibility features were available as part of their school infrastructure, by country
Source: Author's elaboration, based on the LiFE head teacher survey.

Teaching and learning materials and assistive technologies
Across all countries, teachers, parents, and children reported shortages of general educational resources and disability-specific materials, such as large-print books, audiobooks and tactile or hands-on manipulatives. Teachers frequently created low-cost materials using locally available resources; such as pebbles and seeds for mathematics in Nepal, or recycled materials for Braille instruction in Mozambique; demonstrating strong innovation in the face of resource constraints. However, these efforts were often individual and isolated, rather than systematic. Paraguay's Accessible Digital Textbooks (ADTs) initiative – developed using UDL principles - was highlighted as a promising effort, enabling students with disabilities to access the same content as their peers without disabilities in accessible formats [13].

Specialist support and teachers with disabilities
Specialist support was scarce across most LiFE countries. Psychologists and physiotherapists were the most commonly available specialists; yet sign language interpreters were scarce, with only 9 per cent of head teachers in Nepal and 5 per cent in Paraguay reporting their availability. Teachers with disabilities remained underrepresented across all LiFE countries and faced acute challenges in their work environments. Interview data revealed that stigma and discrimination from school staff and families, as well as inaccessible school infrastructure and materials, can hinder their ability to carry out their roles effectively. Yet LiFE findings showed teachers with disabilities brought unique strengths to schools and classrooms: greater empathy, a culture of acceptance and equity among staff, adaptive instructional strategies, and the ability to serve as role models for students with disabilities.
"It's wonderful that people with disabilities can also be part of the teaching profession. I am very happy. I completed my Bachelor's using Braille (...) and became a relief primary teacher. My focus is on supporting the education of children with disabilities... Two of my students from this school have successfully passed the Teacher Service Commission exams and are now working as teachers. (Teacher with disability Inclusive school, Nepal)

4. Policy Recommendations

4.1 Recognize: Prioritized actions to recognize children with disabilities include:

- **Foster positive attitudes toward disability aligned with the social and human rights models**. This entails implementing multi-level sensitization campaigns, developed with OPDs, to challenge stigma and stereotypes. Within the education sector, integrate disability-related content into curricula and teacher training that reflects lived experiences [14]. Ensure authenticity and impact by meaningfully involving persons with disabilities—including children—in the design, delivery, and evaluation of all awareness and sensitization efforts [15].

- **Communicate and demonstrate the benefits of disability-inclusive education for all learners** by mobilizing strong political commitment and sustained sensitization efforts that highlight how inclusion strengthens cognitive, social, and emotional outcomes for every student [16]. School leaders and teachers should be engaged as advocates and evidence champions, helping shape positive attitudes, mobilize resources, and create safe, supportive environments for teaching learners with disabilities.
- **Establish educational identification tools to effectively identify barriers to participation and learning, and ensure that appropriate support is provided to children**. This requires designing school-ready tools focused on functional needs and participation, paired with strong teacher training so they can use them effectively and provide timely accommodations. Clear referral pathways must link school-level identification to specialized services through coordinated action across education, health, and social protection [17]. To sustain this system, monitoring mechanisms should be integrated into EMIS to track identification practices, teacher preparedness, available supports, and student outcomes [18].
- **Strengthen collection, analysis, and use of to properly identify barriers to participation and learning, in line with inclusive principles**. This requires reviewing and adapting national and local data systems so they can capture disaggregated information on participation, learning barriers, and support needs. To ensure data quality, officials involved in data collection must be trained to collect, enter, and analyze information accurately, supported by quality-assurance and feedback mechanisms that promote coherence across the system while allowing schools flexibility to respond to local needs [19].

4.2 Reform: Priority actions to reform education systems to become more inclusive include:

- **Strengthen the capacity of mainstream schools to enrol students with disabilities.** This includes fostering collaboration between mainstream and special schools so teachers can benefit from disability-specific expertise; progressively transforming special schools into inclusion support centres that provide ongoing guidance, resources, and specialist services; and expanding community-based outreach to ensure families understand children's right to attend mainstream schools and feel supported in enrolling them [20].
- **Institutionalize the use of inclusive strategies in teaching and learning**. This requires implementing flexible curricula grounded in frameworks such as UDL, cooperative learning, and differentiated instruction [21]; creating opportunities for teachers to share effective inclusive practices and ensuring that teacher training embeds these approaches as core content both in pre-service and ongoing professional development.
- **Transform teacher training to systematically integrate inclusive education**. This means revising pre- and in-service training so disability-inclusive education becomes mandatory and embedded in accreditation [22]; ensuring programmes address the full range of inclusive strategies such as UDL, differentiated instruction, accessible materials, and formative assessment; guaranteeing long-term policy and financing support; and equipping head teachers to foster collaboration, allocate resources, and create school cultures that enable teachers to implement inclusive practices effectively.
- **Identify and institutionalize teaching practices that promote inclusion by embedding them within teacher professional development**. This requires identifying teachers who excel at inclusive practices, creating structured opportunities for peer learning, and formally recognizing the leadership role these teachers play. Governments should use existing monitoring processes to spot these teachers; ministries of education should embed teacher-led learning into national professional development frameworks; and both national and local authorities should provide recognition, training, and incentives that reinforce inclusive practice as a core professional competency [23].
- **Formalize disability-responsive assessment accommodation guidelines**. Ministries of education should map and document current practices to build a comprehensive, adaptable set of options for all learners; teacher training institutes must equip teachers to implement these accommodations; and assessment outcomes should be used to identify learning needs, adjust instruction, and refine curriculum and teacher preparation [24].

4.3 Resource: Prioritized actions to sustaining and enhancing resourcing of inclusive education are:

- **Improve physical accessibility by addressing both transportation and school infrastructure to ensure all children can reach schools and learn within them safely**. This includes developing and enforcing national guidelines for accessible transport, adopting a phased approach to retrofitting vehicles and buildings, embedding Universal Design principles in new school construction standards, and conducting regular accessibility audits [25]. Where resources are limited, immediate low-cost accommodations should be prioritized, such as assigning ground-floor classrooms to groups that include students with physical disabilities, or modifying classroom lighting and acoustics.
- **Strengthen resource provision and scale teacher-created low-cost materials**, by mapping existing resources and gaps, and combining system-wide investments with targeted funding for accessible materials, assistive devices, and specialist support across central, regional, and local levels. Governments should explore expanding access to multidisciplinary specialists through itinerant models and cross-sector coordination [26]. Teacher-created low-cost materials should be systematically documented and scaled through open-access repositories integrated into national planning, while AI-supported tools are promoted to speed up the creation of accessible resources under clear policies, ethical standards, and UDL-aligned training [27].
- **Recruit and support teachers with disabilities through inclusive recruitment practices.** Teacher training programmes at all levels must provide accessible infrastructure, assistive technologies, and UDL-aligned content, guaranteeing appropriate support from enrolment to certification. Schools should also enforce accessibility standards in buildings, materials, and assistive devices, enabling teachers with disabilities to perform their roles without barriers [28]. Head teacher preparation should also incorporate disability awareness to eliminate hiring bias.

5. Conclusions

The LiFE research demonstrated that the exclusion of children with disabilities is not inevitable but stems from addressable gaps in infrastructure, teacher preparation, data, and resources [29]. The evidence showed that inclusion is achievable and already supported by promising practices. Doing so requires political will, sustained investment, coordinated action, and a shift toward viewing diversity as a strength; recognizing children with disabilities as rights-holders, reforming systems to meet their needs, and resourcing schools with accessible environments and specialist support can drive meaningful transformation for all learners. The full report is available here.

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Student Assessment

Protective Factors Across School Trajectories: Socioeconomic and Racial Disparities

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Abstract

School dropout constitutes a multifaceted, relational process of disengagement from school, resulting from the interweaving of socioeconomic, cultural, and institutional determinants and the insufficiency of educational structures and support networks [1], which makes it essential to identify vulnerabilities early and strengthen protective factors throughout school trajectories [2]. This study aimed to analyze the influence of race/color and the Socioeconomic Level Index (INSE) on relational protective factors of school trajectories. Accordingly, a sample of 10,000 synthetic data was used, based on 3,678 valid responses/answers from students of four Brazilian states who completed the Relational Factors for the Risk of School Dropout Scale – Alternative version (IAFREE-A). The synthetic data was calculated using the Gaussian Copula technique, which considers the association between the observed variables in the dataset to estimate new responses, generating a new and bigger dataset. This approach was considered due to the General Law of Data Protection (LGPD), ensuring ethical compliance through the use of anonymized data, nationwide data collection using real data is currently being conducted in Brazil. Analyses were conducted in JASP using Kruskal–Wallis tests with Dunn post hoc comparisons (Holm correction) due to non-normality (Shapiro–Wilk), and effect sizes were estimated using eta-squared (η^2), variables were the scores of the 14 attention factors. Results showed that, for race/color, significant differences were found in E-FAM2 ($p<.001$), E-EST2 ($p<.001$), and E-EST3 ($p=.002$). Brown students reported poorer family support and educational expectations than White, while Black and Brown showed more negative perceptions of school belonging. For INSE, lower levels were associated with greater vulnerability across E-FAM1, E-FAM2, E-COM2, E-EST1, and E-EST3 (all $p<.001$), particularly family support. Protecting school trajectories requires intersectional policies strengthening school inclusivity for racial minorities and economically vulnerable students.

Keywords: *School dropout, School trajectories, School vulnerability, Inequality, Student Assessment*

1. Introduction

School dropout is a persistent problem in contemporary educational systems, with consequences that extend beyond students' individual trajectories and directly affect countries' social and economic development [3]. In Brazil, this phenomenon does not affect all students equally, as it follows patterns that expose and reproduce, within the educational system itself, the structural inequalities of society [4]. The racial dimension makes this inequality even more evident, as Black and Brown youth account for the majority of those who do not complete basic education in the country [5], revealing that school retention is conditioned by racial and socioeconomic factors, causing school dropout to transcend the purely pedagogical dimension and come to reflect broader social inequalities existing in the Brazilian context [4].

The literature has advanced our understanding of this phenomenon and reached an important conclusion: school dropout is not an isolated event, but rather the result of a relational and multifactorial process involving socioeconomic conditions, cultural aspects, institutional factors, and weaknesses in student support networks [6]. As demonstrated in studies, it is evident that school disengagement rarely occurs suddenly, but is preceded by a gradual weakening of the bonds established between the student and the various settings that make up their school experience [3],[7]. It is within this set of relationships that both the main risks and the protective factors for educational trajectories are concentrated, understood as relational elements that, when reinforced, promote student retention and continuity in the

educational system, even in the face of the adversities they face [2]. In this context, the early identification of vulnerabilities, combined with the reinforcement of these protective factors, has been identified as one of the most important strategies for combating school dropout [2].
Among the factors that shape this process, race/color and socioeconomic status stand out as particularly significant structural determinants. Early warning systems for school dropout have shown that students in economically vulnerable situations and belonging to racial minority groups face greater difficulties in staying in school, related both to limited material resources and to the weakening of the support networks that sustain school continuity [8]. Although the importance of these variables is increasingly recognized, studies investigating their effects in an integrated and intersectional manner within the Brazilian context remain limited, particularly when the focus is on relational protective factors, rather than solely on risk indicators or academic performance.
Moving in this direction is essential, since understanding the factors that promote school retention is a prerequisite for developing more effective interventions aimed at promoting equity, as advocated by international agendas focused on safeguarding educational trajectories [2]. Thus, the present study aimed to analyze the influence of race/ethnicity and the Socioeconomic Status Index (*Índice do Nível Socio-Econômico* - INSE) on relational protective factors for the educational trajectories of Brazilian students, assessed using the Relational Factors for the Risk of School Dropout Scale – Alternative version (IAFREE-A) [9]. It is worth highlighting that INSE is a composite indicator developed by INEP that classifies students into eight hierarchical groups, from Group I (lowest) to Group VIII (highest), based on the parents' level of education and the household's possession of goods and services, making it a widely used measure to capture socioeconomic stratification in the Brazilian education system [10].

2. Method

2.1 Participants

The sample consisted of 10,000 synthetic data points generated from 3,678 valid responses from students, with a predominance of females (50.82%), students of brown race (54.88%), and those in Group V of the Socioeconomic Status Index (INSE) (21.66%). In addition, a higher concentration of participants was observed in the Midwest region (44.35%), followed by the Southeast (25.72%). All sociodemographic characteristics are presented in Table 1.

Table 1. Sociodemographic profile of the sample.

Gender	n	%	Race/Ethnicity	n	%
Male	4898	48.98	White	2168	21.68
Female	5082	50.82	Black	2062	20.62
I prefer not to declare	20	0.20	Brown	5488	54.88
			Other	282	2.82
Region of Residence	n	%	Socioeconomic Status Index	n	%
Midwest	4435	44.35	I	196	1.96
Northeast	1368	13.68	II	1101	11.01
North	1625	16.25	III	1525	15.25
Southeast	2572	25.72	IV	2042	20.42
			V	2166	21.66
			VI	1592	15.92
			VII	1222	12.22
			VIII	156	1.56

2.2 Instruments

The final version of the Scale of Relational Factors for the Risk of School Dropout – Alternative Version (IAFREE-A) [9], an adaptation of the IAFREE originally developed by Vasconcelos et al. [7], aligned with and guided by the concept of School Trajectory Protection. In this sense, the instrument is completed exclusively by students and consists of 46 items, organized into 5 relational dimensions and 14 attention factors. The 5 dimensions are designated as protective dimensions, namely: Student-School (SSc), Student-School Professionals (SP), Student-Family (SF), Student-Community (SC), and Student-Student (SSt), totaling 14 factors of attention: Infrastructure (SSc1); School as a Safe Space (SSc2); Discrimination (SSc3); School Management and Organization (SP1); Pedagogical Quality (SP2); Teacher expectations (SP3); Parenting (SF1); Family support structure (SF2); Family interaction (SF3); Network interaction (SC1); Community relations (SC2); Interpersonal relationships and social skills (SSt1); Expectations regarding education/educational development (SSt2); Belonging/Identification (SSt3). Responses are recorded on a 1-to-4 Likert scale in two formats: frequency (1 = "Never," 2 = "Sometimes," 3 = "Frequently," and 4 = "Always") and agreement (1 = "Strongly disagree," 2 = "Disagree," 3 = "Agree," and 4 = "Strongly agree"), both accompanied by a pictorial scale. In general, the scores are reversed, with the exception of items Q5 and Q36, whose statements are already negative, such that higher scores indicate greater attention to the educational trajectory, while lower scores reflect lower vulnerability. Additionally, a 33-item sociodemographic questionnaire was administered to characterize the participants' profiles, covering variables such as gender, race/ethnicity, Socioeconomic Status Index, and others.

2.3 Procedures

The study was conducted in accordance with ethical guidelines for research involving human subjects, as per National Health Council Resolutions No. 466/2012 and No. 510/2016, and was approved by the Human Research Ethics Committee (CEP/UFAL) under approval No. 5.407.594. Thus, data collection was carried out with students in schools from four state school systems, located in the Central-West, Northeast, North, and Southeast regions of Brazil. For this data collection, a specific digital platform was developed for the administration of the IAFREE-A, where students gained access to the platform only after their parents or guardians signed the Informed Consent Form (ICF), and the Informed Assent Form (IAF) was made available on the platform itself for the students.

2.4 Data Analysis

The analysis procedures were performed in R [11], where synthetic data were generated using the Gaussian Copula technique, based on multivariate normal distributions and the integral probability transformation applied to the original data [12]. The adoption of this approach is justified both from a methodological standpoint, as it preserves the dependency structure among variables, an essential aspect in psychometric data where latent factors emerge from correlations between items [13], [14], and from an ethical standpoint, as it ensures the anonymization of information in compliance with the General Data Protection Law (LGPD) [15]. Thus, the correspondence between the synthetic and original data was assessed using the Hellinger distance, which ranges from 0 to 1, with values close to zero indicating greater similarity between distributions and higher values indicating greater discrepancy [16]. In this study, a value of 0.20 was adopted as the criterion for adequacy.

Based on the generation of synthetic data, statistical analyses were performed using the JASP software [17]. A priori, data normality was assessed using the Shapiro–Wilk test ($p < .05$) [18], and since the assumptions were not met, indicating asymmetry [19], nonparametric tests were chosen, specifically the Kruskal–Wallis test for three or more groups, with application of Dunn's post hoc test [20] when necessary. Effect sizes were reported using eta-squared and Biserial rank correlation (Dunn post hoc), following the interpretation of thresholds by Serdar et al. [21] for small (0.20), moderate (0.50), and large (0.80) effects. The scores of the 14 attention factors of the IAFREE-A were used as dependent variables for the comparative tests. As independent variables, race/ethnicity and INSE were used, classified on a scale from I to VIII, where I represents the lowest conditions and VIII the highest, based on a composite score comprising variables such as income, education, and assets.

3. Results

The correspondence between the synthetic data and the original data was assessed using the Hellinger distance (Hd), a metric ranging from 0 to 1, in which values closer to zero indicate greater similarity between the compared distributions. As shown in Table 2, all values found remained below the adopted adequacy criterion (Hd < 0.20), indicating a high degree of similarity between the distributions of the synthetic data and the original data.
Thus, regarding the instrument's dimensions, Hd values ranged from 0.015 (E-EST) to 0.034 (E-COM). Among the factors, however, there was a slightly greater variation, with values ranging from 0.032 (E-ESC2 and E-FAM3) to 0.065 (E-EST2), remaining within the limit considered adequate, reinforcing the quality of the approximation obtained. Meanwhile, race/ethnicity showed Hd = 0.067, while INSE recorded Hd = 0.027, both below the established cutoff point. It is noted that the relatively higher value observed for race/color is possibly related to the greater heterogeneity of this variable in the original sample, which tends to make its synthetic reproduction more complex when compared to more homogeneous distributions.

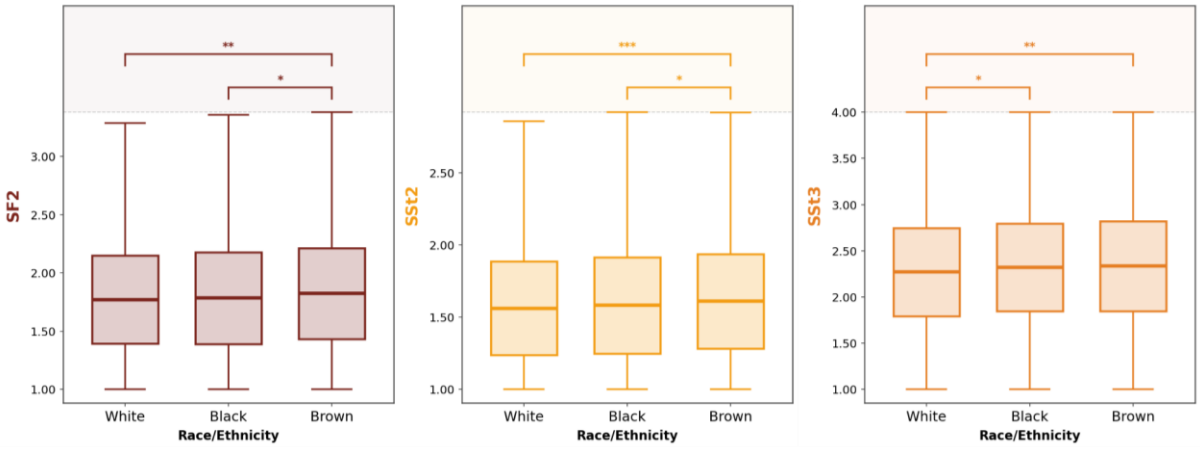
Table 2. Hellinger distance by dimension, factor, and sociodemographic variables.

Dimension	Hd	Factor 1	Hd	Factor 2	Hd	Factor 3	Hd
SSc	0.017	*SSc1*	0.035	*SSc2*	0.033	*SSc3*	0.044
SF	0.026	*SF1*	0.039	*SF2*	0.038	*SF3*	0.032
SP	0.021	*SP1*	0.036	*SP2*	0.035	*SP3*	0.032
SC	0.034	*SC1*	0.037	*SC2*	0.033	—	—
SSt	0.015	*SSt1*	0.038	*SSt2*	0.065	*SSt3*	0.043
Variables		*Race*/Ethnicity	0.067	*INSE*	0.027	—	—

Note. Hd: Hellinger distance. INSE: Socioeconomic Status Index.

With regard to the comparative analyses, for the Race/Ethnicity variable, the Kruskal-Wallis test indicated statistically significant differences in SF2 ($H(2) = 15.34$; $p<0.001$; $\eta^2 = 0.001$), SSt2 ($H(2) = 19.13$; $p<0.001$; $\eta^2 = 0.002$), and SSt3 ($H(2) = 12.60$; $p=.002$; $\eta^2 = 0.001$). Next, Dunn's post hoc test (with Holm correction) was applied to examine paired comparisons between the groups. In this context, regarding the SF2 factor, brown students reported a negative perception of the support structure at home, compared to white students ($z = -3.444$; $p=.002$) and Black students ($z = -2.750$; $p=.012$).

Similar results were found for the SSt2 factor, in which brown students also reported negative perceptions regarding expectations regarding education, when compared to white students ($z = -4.062$; $p<.001$) and Black students ($z = -2.687$; $p=.014$). In contrast, regarding the SSt3 factor, related to feelings of belonging and identification, Black and brown students had higher scores, that is, less positive impressions, than white students ($z = -2.424$; $p=.031$ and $z = -3.524$; $p=.001$, respectively).As illustrated in Figure 1, higher scores reflect greater perceived vulnerability, with Brown students consistently presenting the highest scores across SF2, SSt2, and SSt3, followed by Black students, indicating that racial minority groups experience greater relational vulnerability within the school context.

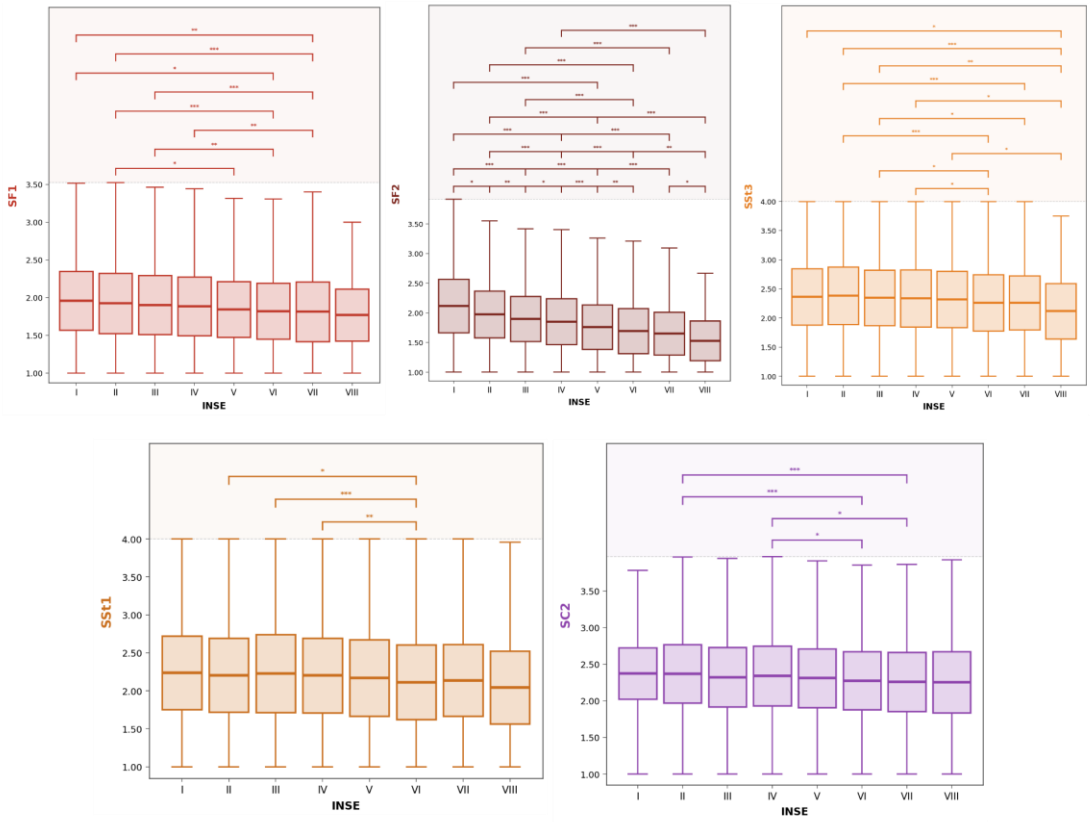


Note. *: p<.05; **: p<.01; ***: p<.001.

Fig. 1. Boxplots of factors showing statistically significant differences across Race/Ethnicity categories.

When considering the Socioeconomic Status Index (INSE) variable, there were statistically significant differences in the factors SF1 ($H(7) = 48.35$; $p < .001$; $\eta^2 = 0.004$), SF2 ($H(7) = 399.1$; $p<.001$; $\eta^2 = 0.039$), SC2 ($H(7) = 33.94$; $p<.001$; $\eta^2 = 0.003$), SSt1 ($H(7) = 32.62$; $p<.001$; $\eta^2 = 0.003$), and SSt3 ($H(7) = 43.41$; $p<.001$; $\eta^2 = 0.004$). When Dunn's post-hoc test was applied, considering the Parenting factor (SF1), Group I had higher scores compared to Groups VI ($z=3.272$; $p=.023$) and VII ($z=3.602$; $p=.008$), suggesting a greater perception of a family environment that does not fully value education and personal development among students from lower socioeconomic backgrounds. Group II, in turn, differed from groups V ($z=3.264$; $p=.023$), VI ($z=4.147$; $p<.001$), and VII ($z=4.622$; $p <.001$), while Group III had higher scores than Groups VI ($z=3.722$; $p=.005$) and VII ($z=4.242$; $p<.001$), and Group IV also differed from Group VII ($z=3.556$; $p=.009$).

As for the Family support structure (SF2), Group I scored higher than all other groups, with Group II ($z=2.508$; $p=.049$), Group III ($z=4.219$; $p<.001$), Group IV ($z=5.391$; $p<.001$), V ($z=7.565$; $p<.001$), VI ($z=9.088$; $p<.001$), VII ($z=9.831$; $p<.001$), and VIII ($z=9.009$; $p<.001$). Group II obtained higher scores than groups III ($z=3.180$; $p=.007$), IV ($z=5.583$; $p<.001$), V ($z=9.993$; $p<.001$), VI ($z=12.59$; $p<.001$), VII ($z=13.53$; $p<.001$), and VIII ($z=9.026$; $p<.001$). Meanwhile, group III scored higher than groups IV ($z=2.452$; $p=.049$), V ($z=7.303$; $p<.001$), VI ($z=10.26$; $p<.001$), VII ($z=11.36$; $p<.001$), and VIII ($z=7.690$; $p<.001$), and group IV differed from groups V ($z=5.224$; $p<.001$), VI ($z=8.517$; $p<.001$), VII ($z=9.769$; $p<.001$), and VIII ($z=6.783$; $p<.001$). Group V also differed from groups VI ($z=3.745$; $p=.001$), VII ($z=5.372$; $p<.001$), and VIII ($z=4.853$; $p<.001$), while groups VI ($z=3.322$; $p=.005$) and VII ($z=2.472$; $p=.049$) obtained higher scores than group VIII. All these high scores indicate that the lower the students' socioeconomic status, the greater their perception of a lack of resources and support within the family context. As shown in Figure 2, scores tend to decrease progressively from Group I to Group VIII, suggesting that students from lower socioeconomic backgrounds report greater vulnerability across the relational factors of their school experience, reinforcing the role of economic disadvantage as a structural determinant within the educational context.



Note. *: p<.05; **: p<.01; ***: p<.001.

Fig. 2. Boxplots of factors showing statistically significant differences across INSE categories.

With regard to Community relations (SC2), significant comparisons were limited to groups II and IV. Group II had higher scores than groups VI (z=4.152; p<.001) and VII (z=4.253; p<.001), a pattern also observed in group IV compared to groups VI (z=3.356; p=.020) and VII (z=3.488; p=.013), indicating a greater perception of distance between the school and the community among students from lower socioeconomic backgrounds. Regarding Interpersonal relationships and social skills (SSt1), it was observed that group II had higher scores than group VI (z=3.256; p=.029), a result also observed in group III (z=4.331; p<.001) and in group IV (z=3.585; p=.009), suggesting that students from lower socioeconomic backgrounds perceive more conflictual interpersonal relationships, with less empathy and greater communication difficulties.

On the Belonging/Identification factor (SSt3), Group I scored higher than Group VIII (z=3.071; p=.041), while Group II scored higher than Groups VI (z=4.490; p<.001), VII (z=4.229; p<.001), and VIII (z=4.257; p<.001), and Group III scored higher than Groups VI (z=3.329; p=.020), VII (z=3.101; p=.041) and VIII (z=3.658; p=.006). In turn, Group IV obtained higher scores than Groups VI (z=3.101; p=.041) and VIII (z=3.513; p=.011), while Group V stood out with higher scores compared to Group VIII (z=3.245; p=.026), suggesting that the lower the students' socioeconomic status, the lower their sense of belonging and identification with the school environment.

4. Discussion

The close correspondence between the synthetic data and the original data indicates that the synthetic generation process successfully preserved the sample's distributional structure without introducing distortions that could compromise the analyses performed. Recent evidence demonstrates the effectiveness of using synthetic data both in medical contexts and in reproducing complex behavioral patterns [21], [22], with similarities between those studies and the present one. Furthermore, beyond being a satisfactory methodological result, this finding has significant ethical relevance, as the use of these data enables robust statistical analyses while simultaneously strengthening the protection of participants' privacy. In this context, the slightly higher value observed for race/ethnicity, for example,

should not be interpreted as a limitation of the method, but rather as a reflection of the greater heterogeneity of this variable in the original sample, a characteristic that makes its reproduction more complex, as well as reinforcing its centrality to the study's objectives, since the indices remained within the established adequacy limits.

Based on this premise, and ensuring the consistency of the data, the analyses show that the school experience, particularly among mixed-race students, is marked by relational vulnerabilities that manifest themselves both in the family environment and in the expectations formed regarding the future. Within the family context, these students perceive fewer resources and less support at home to sustain their educational trajectory, a pattern that can be interpreted as a reflection of historical conditions of exclusion that limit not only access to material goods but also the presence of educated role models within the family unit, which, in turn, compromises the concrete and symbolic support that the family can offer the student [24]. Furthermore, this context fosters a more uncertain perception of the concrete benefits of schooling, contributing to a cycle in which social vulnerability also translates into less subjective investment in one's own educational trajectory [8].

Furthermore, low expectations are directly linked to a weakened sense of belonging in school. Students from racial minorities reported a greater sense of not belonging compared to white students, a condition that influences fundamental aspects of their educational trajectory, such as motivation, attendance, and retention. Recent evidence suggests that this process tends to intensify across educational levels [25] and stems not only from abstract identity conflicts but also from concrete experiences of exclusion and devaluation encountered in daily school life [8]. The fact that race/color-related effects were concentrated primarily in subjective and affective dimensions, such as support, expectations, and belonging, rather than in more objective aspects of the school structure suggests that racial inequalities are expressed above all in students' daily experiences. Precisely for this reason, these processes tend to elude more traditional educational indicators, even though they have a decisive impact on the continuity of the educational journey.

Similarly, socioeconomic inequalities also revealed a broad pattern of relational vulnerability. It was observed that the lower the students' socioeconomic status, the more negative their perceptions of family support, community ties, and school integration were. The perception of insufficient resources in the home environment appears to affect not only the material conditions for studying but also the possibilities for emotional support and involvement in school life, a situation that should not be interpreted as a lack of interest on the part of families, but rather as a consequence of contexts in which the demands of survival limit the concrete conditions for participating in their children's educational journey [26].

At the same time, the greater perceived distance between schools and communities in lower-income groups suggests weaknesses in the connection between educational institutions and the social environment in which these young people live, fostering disengagement when schools fail to engage with students' experiences, cultural references, and everyday realities [6]. Consequently, the combination of these material, relational, and emotional factors helps us understand that school dropout rarely occurs abruptly. In many cases, it is preceded by a gradual and silent process of subjective withdrawal, marked by low participation, difficulties in integration, and strained relationships with peers and teachers, aspects that often go unnoticed by conventional educational indicators [27].

That safeguarding students' educational trajectories requires recognizing that school retention is, above all, a relational issue, and that effective interventions must address the conditions that make the school environment a welcoming, inclusive, and meaningful space for all students, regardless of their racial background or economic status. Future research with longitudinal designs and more regionally diverse samples could deepen our understanding of the mechanisms through which these inequalities are consolidated or mitigated over time, contributing to the development of educational policies that are more equitable and sensitive to the heterogeneity of the Brazilian context.

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The Impact of the Student's Relationship with the School, Family, Professors, and the Community on One's Subjective Perception of the School

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Abstract

The present study aimed to investigate the impacts of external variables of school trajectories on the students' subjective perceptions of interpersonal relationships and sense of belonging in school, in addition to the expectations regarding education. To this end, we used the IAFREE-A questionnaire, which is based on the perspective of five related dimensions of school dropout risk [1]: students' relationship with the school (SSc), family (SF), school professionals (SP), community (SC), and students' relationship with themselves (SSt). Thus, a Structural Equation Modeling was used to investigate the influence of SSC, SF, SP, and SC on SSt variables, using a synthetic dataset generated through the Gaussian Copula technique, using a real dataset of 3,678 students from four states in Brazil. This data generation method estimates new responses based on the association between variables in the real dataset, reproducing its factorial structure, and was used in this study due to the General Law of Data Protection (LGPD), ensuring ethical compliance through the use of anonymized data. Nationwide data collection using real-world data is currently being conducted in Brazil. The explanatory model showed excellent results [$\chi^2(898) = 11459.827$; CFI = 0.983; TLI = 0.980; SRMR = 0.038; RMSEA = 0.034 (0.034–0.035)], with regression coefficients indicating a substantial contribution of the perception of school as a safe place to students' levels of interpersonal relationships (B=0.82, p<.001) and expectations regarding education (B=0.59, p<.001), indicating that the higher the perception of school as a safe place, the higher the levels of expectations regarding education and interpersonal relationships. Moreover, School management/organization was the strongest predictor of sense of belonging (B =0.91, p<.001), indicating that an increase in School management and organization leads to an increase in the perception of belonging.

Keywords: *School trajectories, Educational psychology, Risk of school dropout.*

1. Introduction

School dropout and abandonment constitute a multifaceted phenomenon that transcends the mere interruption of formal educational trajectories, resulting from the intertwining of socioeconomic, cultural, and institutional variables that extend beyond purely individual and family circumstances. In most cases, dropout and abandonment represent the outcome of situations in which existing educational structures and support systems prove inadequate to meet the specific needs of students [2].
Defined by the non-renewal of enrollment in the subsequent educational stage, this phenomenon surpasses the strictly pedagogical domain, also constituting a serious public health issue with substantial economic impact [3],[4],[5],[6],[7]. The lack of formal qualifications, frequently resulting from dropout, predisposes individuals to unemployment, intensifying social inequalities and perpetuating cycles of vulnerability. Consequently, this scenario may contribute to rising rates of functional illiteracy and, in extreme cases, correlate with increased crime rates, as well as mental health problems such as elevated stress levels [5],[6],[7],[8],[9].

In response to this multidimensional challenge, it is worth highlighting the existence of the Relational Factors for the Risk of School Dropout Scale (*Instrumento de Avaliação dos Fatores Relacionais do risco de Evasão Escolar* — IAFREE), developed by Vasconcelos et al. [1] and adapted for the context of protecting school trajectories by Freires et al. [10]. The IAFREE is grounded in the theory of relational factors of school dropout risk, which together function as predictors of school dropout. Among these relational factors, the instrument encompasses the relationships between students and the school, school staff, family, community, and among students themselves or their peers.

The Student–Student (SSt) relational dimension reveals that aspects related to students' educational expectations, their interpersonal relationships, and their sense of belonging to the school environment are equally important for protecting school trajectories. In this context, studies such as that of Martinelli, Muelle-Zuniga, and Alves [11] investigated students' perceptions of the learning environment, focusing on harmony, cooperation, participation, engagement, and teacher support. The findings indicate that students with higher academic performance held more positive perceptions of these aspects, suggesting a correlation with motivation and interest in learning.

In this regard, the factor "Interpersonal relationships and social skills" (SSt1) underscores that the interpersonal relationships established within the school environment are fundamental to the construction of positive educational experiences, fostering a climate of trust, self-acceptance, and cooperation that enhances motivation and interest in learning [12]. Conversely, the absence or fragility of these interpersonal bonds may significantly compromise students' attachment to the institution, negatively affecting motivation, socioemotional development, and educational continuity [13].

Furthermore, it is important to note that educational trajectories are shaped by how students perceive the expectations associated with their academic journey. The factor "Educational expectations and educational development" (SSt2) emphasizes that students form expectations regarding the outcomes of their own performance and the value they attribute to academic success. Accordingly, for schooling to be integrated as a meaningful part of students' life projects, it is essential that they believe in their own competencies to achieve positive outcomes [14]. Likewise, the way in which students perceive their academic future directly influences the formation of their expectations regarding their educational trajectory [15]. Thus, the greater the degree of confidence students place in their personal capacities, the greater the tendency to maintain high and consistent educational expectations, which in turn increases the likelihood of completing secondary education and pursuing higher education [16]. This indicates that each student's perception of their own expectations directly shapes the academic choices they make and the level of engagement they sustain with their studies.

Similarly, the factor "Belonging and identification" (SSt3) points to the notion that feeling integrated, recognized, and valued as part of a group constitutes an essential element in the construction of educational trajectories [13]. When students identify with, and are accepted and respected by, their peer group, affective and social bonds are strengthened, thereby fostering continuous engagement in school activities and contributing to the development of subjective well-being throughout the school career. This sense of belonging extends beyond its immediate effects on academic performance, playing a structuring role in the psychosocial dynamics that underpin the entire academic journey [17].

2. Methods

2.1 Participants

The sample was composed of 10,000 synthetic data, generated through a real sample of 3,678 students from four out of five regions of Brazil (except for the South region). The synthetic data was generated based on the resemblance to the real one, so the prevalence of groups listed in Table 1 reflects the real group concentration of the original data. Based on this, the majority of the sample was composed of women (50.82%), self-identified as brown (54.88%), from the center-west region of Brazil (44.35%), and from the middle point of the socioeconomic index (21.66%), that is, neither poor nor rich.

Table 1. Profile of the sample.

Sex	n	%	Race/Color	n	%
Male	4898	48.98	White	2168	21.68
Female	5082	50.82	Black	2062	20.62
Not informed	20	0.20	Brown	5488	54.88
			Other	282	2.82
Regions of Brazil	n	%	Socioeconomic index	n	%
Center-West	4435	44.35	I	196	1.96
Northeast	1368	13.68	II	1101	11.01
North	1625	16.25	III	1525	15.25
Southeast	2572	25.72	IV	2042	20.42
			V	2166	21.66
			VI	1592	15.92
			VII	1222	12.22
			VIII	156	1.56

2.2 Procedures

Data collection was aligned with the ethical statements for research with human beings, based on the Resolutions No. 466/2012 and No. 510/2026 of the National Health Council of Brazil, and the project was approved by the Research Ethics Committee with Human Beings from the Federal University of Alagoas in the process number 5,407,594. The scope of data collection reached four out of five regions of Brazil, being: North, Northeast, Center-West, and Southeast (except for the South region). During questionnaire administration, the Informed Consent Form (ICF) was available on the platform of data collection, and the Informed Assent Form (IAF) was shared with parents days before administration. Moreover, it is important to highlight that the data derived from the administration was used to generate the synthetic dataset of 10,000 samples used in this study.

2.3 Instruments

The final version of the Relational Factors for the Risk of School Dropout Scale - Alternative version (IAFREE-A) was used [10]. The IAFREE-A is an adaptation of the original scale, developed by Vasconcelos et al. [1], that was based on the evaluation of the risk of school dropout using students' relational factors, being: Student-School (SSc), Student-School professionals (SP), Student-Family (SF), Student-Community (SC), and Student-Student (SSt). The alternative version is aligned and oriented towards the concept of School Trajectory Protection. The original version of the instrument was based on two respondents: the students and the professors of the school, but in the revised version of the instrument, the target audience has changed to students only [18]. In addition, the alternative version maintains this characteristic, being administered with students only. Another important change relies on the scale length. While the original and revised versions had only 36 items, the alternative version is composed of 46 items.

Moreover, the IAFREE-A is based on a hierarchical factor structure, with five relational dimensions and two or three factors each, being: Infrastructure (SSc1); School as a safe space (SSc2); Discrimination (SSc3); School management and organization (SP1); Pedagogical quality (SP2); Teacher expectations (SP3); Parenting (SF1); Home support structure (SF2); Family interaction (SF3); Network interaction (SC1); Community relations (SC2); Interpersonal relationships and social skills (SSt1); Expectations regarding education/educational development (SSt2); Belonging/Identification (SSt3). Response categories vary from 1 to 4 in two settings: frequency (1 = "Never", 2 = "Sometimes", 3 = "Frequently" and 4 = "Always") and agreement (1 = "Strongly disagree", 2 = "Disagree", 3 = "Agree" and 4 = "Strongly agree"), and both are administered with pictorial scales, in addition to the number and label. The items of IAFREE-A have positive descriptions, and by that, they are reverse-scored after the data collection, with the exception of items Q5 and Q36, which already have negative descriptions. Due to the reversion, higher scores reflect higher vulnerability of the student in the relational factors or dimensions.

2.4 Data Analysis

Initially, the synthetic data generation technique was used through the Gaussian Copula Machine Learning technique [19]. This is a synthetic data generation technique that represents real data by transforming each original variable into a uniform scale (through ranks or empirical distribution functions), then projecting these uniform variables into a latent space with a multivariate normal distribution. From the Gaussian correlation matrix, new normal latent vectors are simulated, which are transformed to the aforementioned uniform scale, and finally, are converted back to the marginal distributions of each variable, as originally. Moreover, the resemblance of the synthetic data was investigated through the analysis of the Hellinger distance, which ranges from 0 to 1 and indicates how close the two distributions are, with values closer to 0 indicating similarity, while values closer to 1 indicate substantial differences between the real and synthetic data [20]. For the study, values up to 0.20 were used as the cutoff point for the Hellinger distance.
In addition, further investigation was conducted to evaluate the resemblance of the synthetic and real data, considering psychometric analyses, due to the nature of the data. Based on this, Confirmatory Factor Analysis (CFA) models were used for the IAFREE factors, in order to evaluate the factorial invariance of the two samples. The Weighted Least Squares Mean and Variance Adjusted (WLSMV) estimator was used, due to the ordinal nature of the items [21]. Thus, to assess the fit of the CFA model, the following fit indicators were used: a) $\chi 2$: with significant results indicating perfect fit of the model; c) Comparative Fit Index (CFI) and Tucker Lewis Index (TLI): with results ≥ 0.90 indicating satisfactory model fit, and ≥ 0.95 indicating excellent model fit; Root Mean Square Error of Approximation (RMSEA): which presents adequate results when ≤ 0.08, with the upper limit of the indicator not exceeding values of 0.10 [22]. Factor loadings were considered adequate when ≥ |0.40|.
In addition, Multigroup Confirmatory Factor Analysis (MCFA) was also used to investigate the invariance of the instruments between real and synthetic data, that is, whether the factorial structure of the instruments in the real data is also reproduced with the synthetic data. The hypothesis tested is that, since the synthetic data generation technique used in this study is based on the correlation between variables (as are clustering techniques such as factor analysis), the factor structure of the instrument is expected not to change between the real and synthetic data. To analyze this hypothesis, the following models were used: a) configural invariance: which investigates whether the factor structure remains the same for the real and synthetic data (number of latent factors, items explained by each latent factor, etc.); b) metric invariance: which aims to investigate the equivalence of factor loadings between groups, that is, it assesses whether the magnitude of the relationships between the items and their respective latent factors is statistically similar in the real and synthetic data; c) scalar invariance: which investigates whether the scores are related to the level of latent trait in the real and synthetic data [23],[24]. For the assessment of factorial invariance in these models, the criteria used were $\Delta CFI < 0.01$ and $\Delta RMSEA < 0.015$ [25]. Finally, a Structural Equation Model was tested to estimate the impact of the factors of Student-School (SSc), Student-School professionals (SP), Student-Family (SF), and Student-Community (SC) on the Student-Student (SSt) factors. For this purpose, the same estimator and fit indices were used.

3. Results

Initially, the differences between real and synthetic data, generated using the Gaussian Copula technique, were investigated using Hellinger distance indicators. The results showed that the data presented adequate similarity, with a mean Hellinger distance of 0.060 (SD = 0.008), indicating that the synthetic data adequately represent the real data. Furthermore, MCFA was used to investigate the factorial invariance of the measure, considering both real and synthetic data. The results of the multi-group factorial models indicated that there was no factorial invariance when comparing the real and synthetic datasets, indicating that the factorial structure of the instrument did not vary according to the generation of the synthetic data (Table 2).

Table 2. Fit indices for factorial invariance and predictive model.

	x2(df)	CFI	ΔCFI	TLI	RMSEA	ΔRMSEA	SRMR
Configural	42972.685 (1930)	.962		.960	.056		.060
Metric	43574.949 (1971)	.962	.000	.960	.056	.000	.060
Scalar	43409.864 (2017)	.962	.000	.961	.055	-.001	.060
Predictive	3968.681 (898)	.985		.983	.031		.036

Furthermore, the analysis of the predictors of the student-to-student dimension factors indicated that, for the interpersonal relationships factor, the impact of the variables of discrimination, perception of the school as a safe space (β = .82, p < .001) and discrimination (β = .14, p < .001), stemming from the student's relational dimension with the school, was observed, in addition to the impact of support at home (β = .24, p = .035), stemming from the student's relational dimension with the family. Furthermore, the impact of teachers' expectations (β = -.26, p < .001) and school organization (β = .57, p = .012) on students' interpersonal relationships was also observed, both derived from the student's relational dimension with school professionals. The results indicate that the greater the perception of the school as a safe space, school organization, and support at home, the better the student's interpersonal relationships will be. Furthermore, it can also be observed that the increase in experiences of discrimination can subtly increase interpersonal relationships, while teachers' expectations tend to negatively impact interpersonal relationships. The strongest predictor of the interpersonal relationships variable was the perception of the school as a safe space, and the model explained 81.5% of the variance of this variable.

As for the belonging factor, the impact of infrastructure (β = -.17, p = .033), family involvement (β = -.34, p = .012), associations with the school system (β = .57, p = .003), pedagogical quality (β = -.40, p = .037), and school organization and management (β = .91, p = .004) was observed. It was observed that increased engagement with the network and school organization and management impact the increase in students' sense of belonging, while increased family involvement, pedagogical quality, and a better perception of infrastructure were associated with a decrease in the sense of belonging, with the latter relationship being the weakest. The most important predictor of the sense of belonging was school management and organization, and the model explained 49.0% of the variance in the belonging variable.

Finally, for the factor of expectations regarding education, it was observed that the impact of the perception of the school as a safe space (β = .59, p < .001), school infrastructure (β = -.25, p < .001), family involvement (β = .26, p < .001), teachers' expectations (β = -.20, p < .001), and school management and organization (β = .64, p = .005) was significant. Therefore, it is possible to infer that the increased perception of the school as a safe space, family involvement, and school organization impact the increase in expectations regarding education. On the other hand, it was also observed that the higher the teacher expectations and school infrastructure, the lower the expectations regarding education. The most important predictor of expectations regarding education was school management and organization, and the model explained 72.2% of the variance in the expectations regarding education variable.

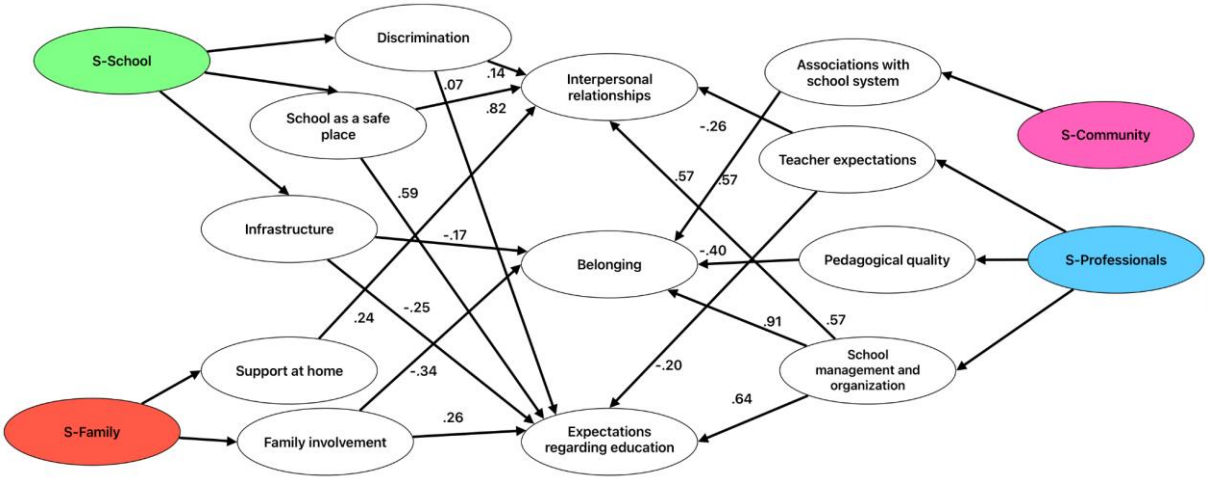


Fig. 1. Structural model for the predictors of Student-Student dimension.

4. Discussion

The aim of this study was to investigate the predictors of the subjective factor among the relational factors of school dropout risk, from the perspective of protecting school trajectories, considering as potential predictors the relational factors between the student and the school, school staff, family, and community. To this end, a synthetic database was employed, generated from a sample of 3,678 students across four regions of Brazil. Initial results indicated that there was no factorial structure invariance when comparing the real and synthetic datasets. In addition, Hellinger distance indicators yielded low values, suggesting that the synthetic data faithfully represented the real data, a result consistent with findings from recent studies supporting the utility of synthetic data in health-related settings as well as in capturing intricate behavioral dynamics [26],[27].

Regarding the predictive analyses, the structural model explained 81.5% of the variance in the interpersonal relationships variable, with the perception of school as a safe space being the strongest predictor. A modest positive impact of discrimination on interpersonal relationships was also observed. The hypothesized mechanism underlying the predictive impact of discrimination was the formation of groups through homophily, in which individuals tend to interact more frequently with others from the same group, as suggested by Kogachi and Graham [28], who found that adolescents from racial minority groups showed stronger friendships with members of the same group. Accordingly, this hypothesis may be extended to the findings of the present study through the interpretation that groups of students who experience discrimination at school tend to develop stronger relational bonds among themselves, which would explain the small yet positive impact observed in the structural model analysis.

With respect to the sense of school belonging factor, the model explained 49% of the outcome variance, and the strongest predictor was school management and organization. Conversely, higher levels of family involvement were associated with lower sense of school belonging, which may be accounted for by the helicopter parenting hypothesis, in which parents display intrusive, controlling behaviors toward their children [29], thereby reducing peer attachment [29] and increasing negative affect [30].

Furthermore, for the educational expectations variable, the structural model explained 72.2% of the outcome variance, with school management and organization again emerging as the strongest predictor. The study by Johnson, Pas and Bradshaw [31] found a positive association between emotional and service support, rules and consequences, and adolescents' future orientations in a sample of 27,698 students across 12 countries. This finding supports the view that clear communication of rules and administrative support are directly associated with students' expectations regarding their own educational trajectories.

Based on these findings, it was possible to observe that the relational factors of school dropout risk are not only potentially associated, as the underlying theory proposes [1], but may also act as predictors of one another. The results revealed substantial predictive impacts, particularly for interpersonal relationships (81.5%) and educational expectations (72.2%), indicating an important relationship among the variables examined in this manuscript. Among the study's limitations, the absence of longitudinal analyses or analyses distinguishing different stages of school development is noteworthy, as these would allow for the investigation of relationships among variables over time and across students'

educational trajectories. Furthermore, it should be noted that the sample used as the basis for generating the synthetic data was not representative of the Brazilian population, which limits the generalizability of the findings. Finally, it is considered that the findings of this study may contribute to the interpretation of how various school contextual variables can impact students' subjective experiences, as well as their peer relationships within the school environment.

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Latent Profiles of School Trajectory Risk and Sociodemographic Patterning in Brazilian Public Education

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Abstract

School dropout and educational disengagement are increasingly conceptualized as cumulative and relational processes shaped by the interplay of institutional, familial, relational, and structural factors, requiring multidimensional approaches that account for both the configurations of risk and their social patterning. This study aimed to identify latent profiles of school trajectory risk among Brazilian public school students and to examine how these profiles are sociodemographically patterned across gender, race/ethnicity, socioeconomic status, and student labor participation. Accordingly, a sample of 10,000 synthetic data was used, based on valid responses/answers from students of four Brazilian states (Rondônia, Minas Gerais, Mato Grosso, and Maranhão) who completed the Relational Factors for the Risk of School Dropout Scale – Alternative version (IAFREE-A).The synthetic data was calculated using the Gaussian Copula technique, which considers the association between the observed variables in the dataset to estimate new responses, generating a new and bigger dataset. This approach was considered due to the General Law of Data Protection (LGPD) and the need to ensure the protection of participating children and adolescents. Latent Profile Analysis (LPA) was conducted using the five aggregated dimensions of the IAFREE-A — student–student, student–school, student–school-professionals, student–family, and student–community. Model [1] selection followed an analytic hierarchy process based on multiple fit indices (Akogul & Erisoglu, 2017). The best-fitting solution was a three-class model (BIC = 59,332; entropy = 0.79; minimum classification probability = 0.88), with profiles interpreted as low (27.2%), medium (53.9%), and high risk (18.9%), showing monotonic separation across all five dimensions, with high-risk students presenting elevated scores in the student–school (M = 2.98) and student–community (M = 2.91) domains. Subsequently, chi-square analyses examined associations between profile membership and sociodemographic variables. A statistically significant association emerged for gender ($\chi^2 = 118.47$; $p < .001$; $V = 0.077$): female students were over-represented in the high-risk profile (adjusted residual = +8.91), whereas male students concentrated in the low-risk profile (+8.02). Associations with socioeconomic level (V = 0.033), student employment (V = 0.022), and race/ethnicity (V = 0.007) were weak and non-significant. Findings indicate clear, well-separated multidimensional profiles of school trajectory risk and a robust gendered patterning of vulnerability, supporting a process-oriented understanding of school trajectory risk under LGPD-compliant research conditions.

Keywords: *latent profile analysis; school trajectories; educational inequality; Gaussian copula*

Introduction

School dropout is currently understood as a processual and multifactorial phenomenon, although debates persist regarding which factors influence this process and the extent of their effects [1,2]. The literature also presents conceptual divergences concerning the meaning of the term “school dropout.” In the present study, the definition adopted follows the criteria established by the National Institute for Educational Studies and Research (INEP), which distinguishes between dropout (*evasão escolar*) and school abandonment (*abandono escolar*). According to INEP, dropout refers to a transition rate indicating the absence of enrollment in any school in the year following the school census, whereas school abandonment refers to a school-flow indicator that captures the interruption of attendance after the census reference date [3]. These phenomena should not be interpreted as definitive conditions by nature, since they may represent temporary interruptions within educational trajectories and may therefore be reversible.

Although this distinction introduces analytic nuances, dropout and abandonment still correspond to specific moments within broader educational trajectories. In this context, several Latin American countries have increasingly incorporated the notion of school trajectories into public educational policies, conceptualizing dropout and abandonment as possible events within these trajectories rather than as their totality [4]. This perspective is associated with the concept of trajectory protection, which shifts the focus from the prevention of isolated events toward the promotion of conditions that sustain students' educational continuity through institutional, personal, and contextual support mechanisms during the schooling process [5].

Studies indicate that weak school belonging, negative peer interactions, low perceived support from teachers, family disengagement, and community vulnerability are associated with indicators of school disengagement, absenteeism, low academic investment, and dropout intention [6-10]. These findings support the proposition that school trajectory risk emerges through the articulation of multiple relational dimensions rather than through isolated predictors [11, 1].

Based on this framework, the Instrument for the Assessment of Relational Factors for the Risk of School Dropout – Alternative Version (IAFREE-A) was developed according to the Relational Model [12]. The instrument integrates protective dimensions and indicators of vulnerability associated with school abandonment and dropout into a single multidimensional assessment, enabling the measurement and prediction of the complex relational system underlying these phenomena and providing a comprehensive understanding of students' educational experiences within the school context [13,14]. The IAFREE-A comprises 14 relational factors distributed across five essential dimensions: Student–School, Student–School Professionals, Student–Family, Student–Community, and Student–Student [12].

In the Brazilian public education context, school trajectories are shaped by structural inequalities associated with territorial disparities, socioeconomic precariousness, institutional instability, and unequal access to educational resources [15, 16]. Although dropout rates have declined in recent decades, indicators of school disengagement and interrupted trajectories remain concentrated among students exposed to conditions of social vulnerability [17, 18]. Research in this field has also examined the role of sociodemographic variables, such as gender, race/ethnicity, socioeconomic level, and adolescent labor participation, in the distribution of educational risk [19, 20]. However, findings remain inconsistent, particularly when relational and contextual dimensions are incorporated into the analytic models [21].

Most studies investigating school dropout employ variable-centered approaches, such as regression models and correlational analyses, which estimate the independent contribution of predictors to educational outcomes [22, 8]. Although these approaches provide evidence regarding associations between variables, they are limited in identifying heterogeneous subgroups characterized by distinct configurations of risk [23, 24]. Person-centered approaches, such as Latent Profile Analysis (LPA), enable the identification of latent subpopulations based on response patterns across multiple indicators [25, 26]. In the context of school trajectory research, LPA allows the estimation of qualitatively distinct profiles of relational vulnerability, contributing to the understanding of how different dimensions co-occur within individuals [27, 6].

Therefore, the aim of this study is to identify latent profiles of school trajectory risk among Brazilian public school students and to examine how these profiles are sociodemographically patterned across gender, race/ethnicity, socioeconomic status, and student labor participation.

Method

Design

This is a quantitative, cross-sectional, non-experimental study conducted on a synthetic dataset. The research combined a person-centered approach, through Latent Profile Analysis (LPA), with a group-comparison approach, through chi-square association tests, with the aim of identifying latent profiles of risk in school trajectories and examining how these profiles are distributed across students' sociodemographic characteristics.

Ethical Considerations and Generation of the Synthetic Dataset

Given the sensitive nature of educational data involving children and adolescents, and in compliance with the Brazilian General Data Protection Law (LGPD — Law no. 13,709/2018), the analyses were conducted on a synthetic dataset, constructed from the original responses of students to the IAFREE-A

instrument. Data analyses were conducted using the R statistical environment [28]. Synthetic data were generated using the Gaussian Copula technique, which is based on multivariate normal distributions combined with probability integral transformations of the original data [29]. One of the main advantages of this approach is that it preserves the dependency structure among variables [30], which is particularly important for psychometric data because latent constructs are derived from the correlation structure among observed items [31]. Furthermore, previous studies have demonstrated that the Gaussian Copula approach effectively reproduces the statistical properties of real datasets in diverse fields, including medical research (30, 32] and behavioral sciences [33].
The similarity between the original and synthetic datasets was assessed using the Hellinger distance, an index ranging from 0 to 1 that quantifies the similarity between two probability distributions. Values closer to 0 indicate greater similarity, whereas values closer to 1 indicate greater dissimilarity between the original and synthetic datasets [34]. Following previous recommendations, Hellinger distance values of up to 0.20 were considered indicative of adequate similarity between the original and synthetic datasets.

Sociodemographic Variables

The synthetic dataset comprised 10,000 records simulating public school students from four Brazilian states from the 9th grade of Elementary School to the 3rd year of Upper Secondary Education, generated from a real sample of 3536 students. Regarding gender, the sample was balanced between male (n = 4,898; 49.0%) and female students (n = 5,082; 50.8%), with a small proportion identifying as other (n = 20; 0.2%). In terms of race/ethnicity, 56.2% identified as Indigenous or other (n = 5,620), 23.0% as Black or Brown (n = 2,299), and 20.8% as White (n = 2,081). Most students reported not engaging in paid work (n = 7,933; 79.3%), while 20.7% indicated current labor participation (n = 2,067). The distribution across socioeconomic strata (INSE), ranging from I (lowest) to VIII (highest), concentrated in the middle levels (strata III to VI accounted for 73.3% of the sample), with smaller proportions in the extreme strata (3.5% combined in I and VIII).

Instrument

The study used the Instrument for the Assessment of Relational Factors for the Risk of School Dropout - Alternative version (IAFREE-A), a multidimensional scale developed to assess protective and risk factors in school trajectories across five relational dimensions: (a) Student–Student (SSt), which captures interpersonal relationships, social skills, educational expectations, and sense of belonging among peers; (b) Student–School (SSc), which encompasses the perception of school as a safe place and institutional responses; (c) Student–School Professionals (SSP), referring to the relationship with teachers and pedagogical staff; (d) Student–Family (SF), which assesses family support and engagement with the student's school trajectory; and (e) Student–Community (SC), referring to the student's relationship with the surrounding community. Each item is answered on a four-point Likert scale, with higher scores indicating that a higher level of attention is required for this school trajectory.

Analytical Procedures

Analyses were conducted in R software, version 4.4 [28], using the tidyLPA package [35] for latent profile estimation. Latent Profile Analysis (LPA) was conducted using the mean scores of the five aggregated dimensions of the IAFREE-A (SSt, SSc, SSP, SF, SC) as indicators. Solutions ranging from two to five classes were compared, all estimated under the specification of equal variances between classes and zero covariances (Model 1 of tidyLPA). The selection of the optimal number of classes followed an analytic hierarchy process based on multiple fit indices [7], including AIC, AWE, BIC, CAIC, CLC, KIC, and SABIC, complemented by the examination of entropy, minimum and maximum classification probabilities, and the conceptual interpretability of the solutions. The random seed was fixed (set.seed = 2024) to ensure analytic reproducibility.
After selecting the final solution, each participant was assigned to the latent class with the highest posterior probability, and the profiles were labeled as low, medium, and high risk based on the aggregated means of the five dimensions
Subsequently, Pearson's chi-square association tests were conducted to examine the relationship between latent risk profile and each sociodemographic variable. Effect size was estimated using Cramér's V, and post hoc analysis was performed through adjusted standardized residuals, with cells presenting $|z| > 1.96$ ($\alpha = 0.05$) considered statistically significant. Across all contingency tables, more

than 80% of cells presented expected frequencies above 5, meeting the classical Cochran criterion for the validity of the chi-square asymptotic approximation. The only exception was the cell corresponding to the intersection between the high-risk profile and the "other" gender category (expected frequency = 3.78), which represents 0.2% of the sample and does not substantively affect the inferences of the test.

Results

Selection of the Number of Latent Classes

Table 1 presents the fit indices for solutions ranging from two to five classes. The three-class solution was selected as the most adequate, based on the combination of statistical fit and conceptual interpretability. Although the BIC continued to decrease in solutions with more classes, entropy peaked at three classes (0.785), and the minimum classification probability remained high (0.880), indicating good separation between profiles. The substantive interpretation was also clearer with three classes, with profiles monotonically ordered along increasing levels of risk.

Table 1. Fit indices for solutions from two to five classes (Model 1: equal variances, zero covariances)

Classes	LogLik	AIC	BIC	SABIC	Entropy	Min. Prob.
2	−31,849	63,730	63,845	63,795	0.775	0.923
3	−29,565	59,173	59,332	59,262	0.785	0.880
4	−28,751	57,558	57,760	57,671	0.768	0.826
5	−28,425	56,918	57,163	57,055	0.749	0.774

Characterization of the Latent Profiles

The three-class solution yielded clearly differentiated and monotonically ordered profiles across the five dimensions of the IAFREE-A. The low-risk profile comprised 27.2% of the sample (n = 2,715), with means below 1.80 across all dimensions. The medium-risk profile was the most populous, comprising 53.9% of the sample (n = 5,393), with means between 2.07 and 2.32. The high-risk profile, comprising 18.9% of the sample (n = 1,892), presented the highest means, particularly in the Student–School (M = 2.98) and Student–Community (M = 2.91) dimensions. Table 2 presents the profile means in each dimension.

Table 2. Means of the IAFREE-A dimensional scores by latent profile

Profile	n (%)	SSc	SSP	SF	SC	SSt	Overall mean
Low risk	2,715 (27.2%)	1.66	1.73	1.65	1.79	1.54	1.67
Medium risk	5,393 (53.9%)	2.31	2.25	2.09	2.32	2.07	2.21
High risk	1,892 (18.9%)	2.98	2.82	2.55	2.91	2.64	2.78

The pattern shown in Figure 1 reveals monotonic separation between the three profiles across all dimensions, with progressively greater distances between scores as the level of risk increases. The Student–Family dimension presented the lowest mean scores across all profiles, while Student–School and Student–Community presented the highest mean scores, suggesting that institutional and community dimensions contribute proportionally more to the configuration of risk across all levels.

Figure 1. Latent profile means across the five IAFREE-A dimensions

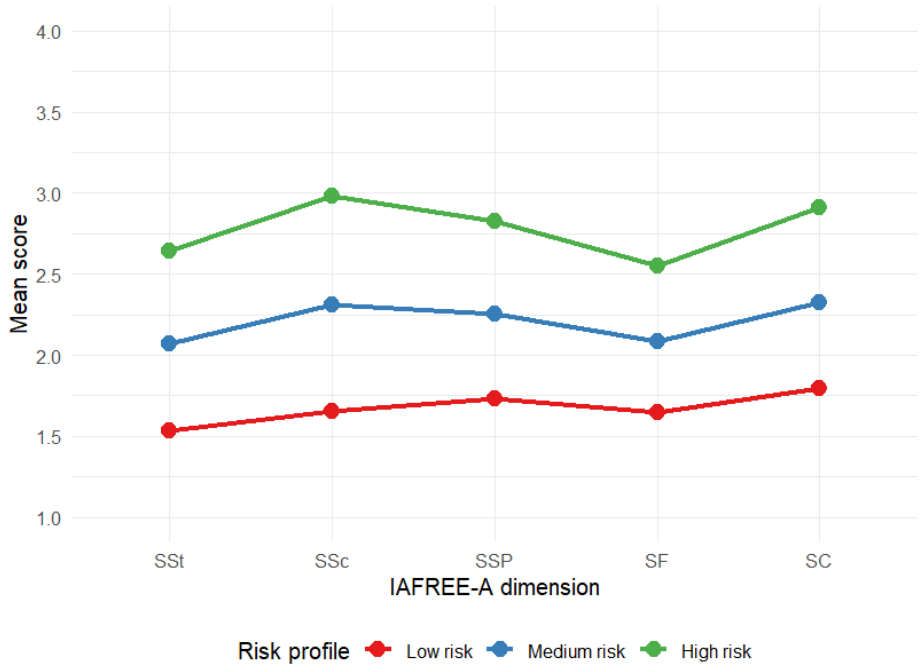
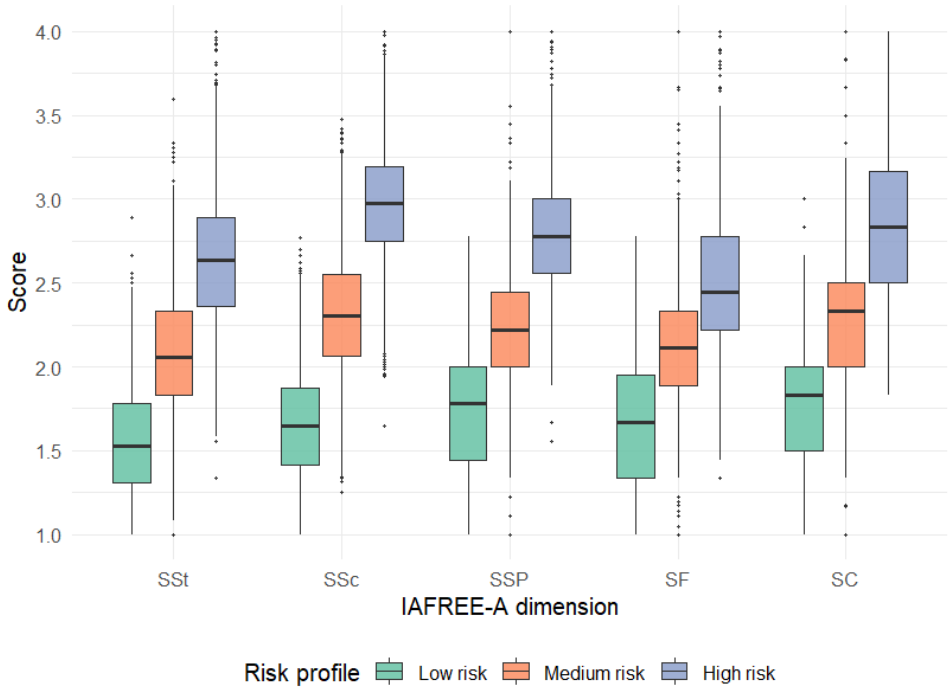


Figure 2. Distribution of IAFREE-A dimensions by latent risk profile



Associations between Latent Profiles and Sociodemographic Variables

Pearson's chi-square tests revealed only one statistically significant association between the risk profile and the sociodemographic variables examined. Table 3 summarizes the results.

Table 3. Chi-square tests between latent profile and sociodemographic variables

Variable	χ^2	df	p	Cramér's V	N
Gender	118.47	4	< 0.001	0.077	10,000
Labor participation	4.90	2	0.087	0.022	10,000
Race/ethnicity	0.98	4	0.913	0.007	10,000
Socioeconomic level (INSE)	21.25	14	0.095	0.033	10,000

Gender

The analysis revealed a significant association between gender and risk profile ($\chi^2(4) = 118.47$; $p < 0.001$; $V = 0.077$). Although Cramér's V indicates a small effect size (which is expected given the large sample size), the adjusted standardized residuals revealed a clear pattern of differential distribution. Male students were significantly over-represented in the low-risk profile ($z = +8.02$) and under-represented in the high-risk profile ($z = -9.13$). Conversely, female students were over-represented in the high-risk profile ($z = +8.91$) and under-represented in the low-risk profile ($z = -7.91$). Table 4 details the frequencies and percentages by category.

Table 4. Percentage distribution of gender by risk profile

Profile	Male	Female	Other
Low risk	55.5%	44.4%	0.1%
Medium risk	49.0%	50.8%	0.2%
High risk	39.5%	60.0%	0.4%

Labor Participation, Race/Ethnicity, and Socioeconomic Level

The associations between risk profile and labor participation ($\chi^2(2) = 4.90$; $p = 0.087$; $V = 0.022$), race/ethnicity ($\chi^2(4) = 0.98$; $p = 0.913$; $V = 0.007$), and socioeconomic level ($\chi^2(14) = 21.25$; $p = 0.095$; $V = 0.033$) did not reach statistical significance. Cramér's V values were all below 0.05, indicating associations of negligible magnitude. Inspection of the contingency tables confirms the near-equivalence of distributions across profiles: for example, the proportion of students who work varies minimally across profiles (19.8% in the low-risk profile, 20.5% in the medium-risk profile, and 22.4% in the high-risk profile), as does the distribution by race/ethnicity (≈21% White, ≈23% Black/Brown, and ≈56% Indigenous/Other across all profiles) and by socioeconomic stratum.

The absence of substantive associations between these sociodemographic variables and the latent profiles, in contrast with the robust finding for gender, suggests that, in the synthetic dataset analyzed, the relational risk structures captured by the five dimensions of the IAFREE-A are distributed relatively homogeneously across socioeconomic, racial, and labor strata, but display a clear pattern of differentiation by gender.

Discussion

The Latent Profile Analysis identified three profiles that were subsequently categorized according to risk level. The low-risk profile presented more homogeneous scores across the IAFREE-A dimensions, whereas higher-risk profiles maintained a similar dimensional configuration but with greater score dispersion. This pattern suggests a cumulative and processual organization of school trajectory vulnerability, indicating that school trajectory risk should not be conceptualized as a dichotomous

phenomenon, but rather as a continuum in which the relative contribution and intensity of relational dimensions vary according to the latent profile configuration [23, 1]. The monotonic separation observed across the profiles also supports the interpretation that different relational domains co-occur in the constitution of educational vulnerability rather than operating as isolated predictors.

Within this configuration, the prominence of the Student–School and Student–Community dimensions in the high-risk profile is notable, indicating greater fragility in students' relationships with the school institution and with the communities in which they are embedded. From an intervention perspective, these findings suggest the relevance of investigating institutional and territorial conditions associated with school trajectories. Based on the literature and on the relational indicators assessed by the instrument, these vulnerabilities may involve perceptions of insecurity within school and community contexts, institutional exclusion, precarious infrastructure, and limited articulation between educational systems and health and social assistance services [11, 8, 1]. In contrast, the Student–Family dimension presented the lowest scores across profiles, suggesting that family relationships remained comparatively more preserved even among high-risk students. This result indicates that family support may function as a protective factor contributing to school permanence up to the moment of data collection.

The chi-square and post hoc analyses also identified a small but systematic overrepresentation of male students in the low-risk profile and female students in the high-risk profile. In conjunction with the relational profile structure, these findings suggest that gendered experiences may differentially shape school trajectories and perceptions of institutional and contextual vulnerability. The observed gender pattern differs from studies reporting higher prevalence of school dropout among male students, particularly in contexts involving labor participation and school interruption. However, the present study operationalized school trajectory risk through relational indicators rather than completed dropout events. In this sense, female students may report higher levels of relational strain, institutional dissatisfaction, emotional burden, or perceived social vulnerability without necessarily presenting higher rates of school abandonment. The findings therefore reinforce the distinction between dropout occurrence and latent configurations of educational vulnerability.

Some limitations should be considered. The cross-sectional design restricts causal inference regarding the development of school trajectory risk over time. The use of synthetic data, although justified by ethical and legal requirements, may attenuate specific distributional characteristics present in the original sample. In addition, the analyses were restricted to students from four Brazilian states, limiting the generalizability of the findings to other educational contexts. Future studies may investigate longitudinal transitions between latent profiles, examine measurement invariance across sociodemographic groups, and incorporate additional indicators such as academic performance, mental health, and school attendance.

Conclusion

The present study identified three latent profiles of school trajectory risk among Brazilian public school students based on the relational dimensions assessed by the IAFREE-A. The profiles demonstrated monotonic separation across the five domains, indicating differentiated configurations of relational vulnerability. The findings support the conceptualization of school trajectory risk as a multidimensional construct involving institutional, interpersonal, familial, and community dimensions.

The results also indicated that gender was the only sociodemographic variable associated with latent profile membership. Female students were disproportionately represented in the high-risk profile, whereas male students concentrated in the low-risk profile. In contrast, race/ethnicity, socioeconomic level, and labor participation did not present significant associations with relational risk configurations in the analyzed dataset.

From a psychometric and methodological standpoint, the study demonstrates the applicability of Latent Profile Analysis for identifying heterogeneous patterns of educational vulnerability and supports the use of multidimensional relational indicators in the assessment of school trajectory risk. The use of synthetic data generated through Gaussian Copula procedures also contributes to the discussion regarding ethical data management in educational research involving minors under LGPD regulations.

The findings reinforce the relevance of multidimensional approaches to school trajectory analysis and indicate that prevention strategies should incorporate relational and contextual dimensions associated with school permanence. Interventions centered exclusively on academic performance indicators may not capture latent configurations of vulnerability associated with educational disengagement. Research is already being conducted on a wider sample encompassing students from all Brazilian states and can

help to investigate how the tendencies observed in the present study vary on a more diverse and representative sample.

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Latent Profiles of Relational Risk in School Trajectories: An Analysis of Gaussian Copula-Synthesized Data from Brazilian Public School Students

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Abstract

Peer relationships and school belonging are central relational dimensions shaping students' school trajectories, particularly in contexts of structural vulnerability. This study aimed to identify latent profiles of relational risk among Brazilian public school students and to examine whether these profiles represent empirically distinct groups, combining person-centered and group-comparison approaches. Given the sensitive nature of educational data involving minors and the requirements of the Brazilian General Data Protection Law (LGPD), analyses were conducted on a synthetic dataset (N = 10,000) generated via a Gaussian Copula procedure, simulating responses from public school students from the 9th grade to the 3rd year of upper secondary education in four Brazilian states. Latent Profile Analysis (LPA) was conducted using the three factors of the Student–Student (SSt) dimension: interpersonal relations and social skills, educational expectations, and belonging/identification. Model selection followed an analytic hierarchy process based on multiple fit indices. The best-fitting solution was a three-class model (BIC = 52,390; entropy = 0.65), with profiles interpreted as low (30.7%), medium (49.7%), and high relational risk (19.6%). Kruskal–Wallis analyses showed significant differences between all classes for the SSt total score (χ^2 = 7,702.60; $p < .001$; $\varepsilon^2 = 0.770$), interpersonal relations ($\varepsilon^2 = 0.687$), and belonging ($\varepsilon^2 = 0.654$), indicating very large effects. Educational expectations differed less ($\varepsilon^2 = 0.081$). Profiles also differed in the student–school dimension ($\varepsilon^2 = 0.359$), particularly perception of school as a safe place ($\varepsilon^2 = 0.318$), and across student–school-professionals ($\varepsilon^2 = 0.189$), student–community ($\varepsilon^2 = 0.171$), and student–family relations ($\varepsilon^2 = 0.150$). Post hoc Dunn comparisons confirmed differences between all groups. Findings indicate well-separated latent profiles of relational risk, supporting a process-oriented understanding of school trajectory risk under LGPD-compliant research conditions.

Keywords: *latent profile analysis; school trajectories; peer relations; Gaussian copula; LGPD.*

1. Introduction

School dropout and school leaving constitute multifaceted phenomena that transcend the mere interruption of the formal educational trajectory, resulting from the interweaving of socioeconomic, cultural, and institutional variables that go beyond purely individual and familial circumstances [25]. Beyond the pedagogical domain, these processes constitute a public health issue with substantial economic impact [3, 14, 28], since the lack of formal qualifications frequently predisposes individuals to unemployment and intensifies social inequalities [9, 27]. Accordingly, the present study aims to identify latent profiles of relational risk among Brazilian public school students based on the factors of the Student–Student dimension of the IAFREE-A, and to examine whether these profiles differentiate significantly across the remaining dimensions of the instrument.

The circumstances surrounding this phenomenon are intricate and interconnected, ranging from socioeconomic factors — such as the early entry into the labor market to supplement family income — to pedagogical issues, including unmotivating teaching methods or the absence of adequate support for struggling students [4, 16, 21, 23]. Problems in the school environment, such as discrimination, violence, or the perception that the institution offers no promising future, also contribute significantly [12]. In Brazil, dropout and school leaving are differentiated by the School Census criteria: school leaving refers to withdrawal during the school year, while dropout is identified when the student fails to enroll for the subsequent year [7] — a distinction that is essential for the formulation of more effective public policies [5].

Dropout and school leaving should therefore be understood not as isolated events, but as processes of disconnection from school, characterized by relational and multifactorial dynamics that reveal structural inequalities historically present in Brazilian society [10]. From this perspective, the notion of school trajectory protection gains relevance, proposing a broader interpretation of schooling that considers transitions, articulations, and linkages across systemic, institutional, and individual dimensions [11, 24]. Students' pathways cannot be understood solely from their individual characteristics, as they reflect broader inequalities related to familial, institutional, and educational contexts [22].
Given this complexity, there is a need for psychometrically adequate measures to assess the factors that may protect school trajectories. In this regard, the Instrument for the Assessment of Relational Factors for the Risk of School Dropout (IAFREE) [26] was developed under a relational and multidimensional approach, organized across five dimensions: Student–School, Student–School Professionals, Student–Family, Student–Community, and Student–Student. Subsequent revised and alternative versions were later developed, including the IAFREE-R [8] and the IAFREE-A-46, the latter shifting the emphasis from identifying risk factors toward the perspective of protection and continuity of school trajectories.

2. Method

2.1 Design

This is a quantitative, cross-sectional, non-experimental study conducted on a synthetic dataset. The research combined a person-centered approach, through Latent Profile Analysis (LPA), with a group-comparison approach, through non-parametric Kruskal–Wallis tests, with the aim of identifying latent profiles of relational risk in school trajectories and examining whether these profiles represent empirically distinct groups across the dimensions of the IAFREE-A.

2.2 Ethical Considerations and Generation of the Synthetic Dataset

Given the sensitive nature of educational data involving children and adolescents, and in compliance with the Brazilian General Data Protection Law (LGPD — Law no. 13,709/2018), the analyses were conducted on a synthetic dataset, constructed from 3536 original responses of students to the IAFREE-A instrument. The Gaussian Copula technique was used for the generation of synthetic data. It is a synthetic data generation technique based on multivariate normal distributions, applied through a probability integral transformation of the real data [13]. One of the advantages of this technique is that it accounts for the dependence (or association) between the variables [2] of a dataset, a feature that is necessary for the use of synthetic data with psychometric variables, since the latent factors derived from such measures are grouped through the correlations between items [6]. Furthermore, the Gaussian Copula methodology has shown satisfactory results in reproducing real data, both in the medical field [2, 20] and in reproducing behavioral patterns [19].
To assess the reproducibility of the synthetic data in relation to the real data, the Hellinger distance indicator was used, which ranges from 0 to 1 and indicates how close or different two probability distributions are. For the interpretation of similarity between the real and synthetic data, values closer to 0 indicate greater similarity, while values closer to 1 indicate greater differences between the original and generated data [15]. In this study, values up to 0.20 were considered adequate.

2.3 Instrument

The study used the Instrument for the Assessment of Relational Factors for the Risk of School Dropout — Alternative version (IAFREE-A), a multidimensional scale designed to assess protective and risk-related factors in school trajectories across five relational domains: (a) Student–Student (SSt), (b) Student–School (SSc), (c) Student–School Professionals (SSP), (d) Student–Family (SF), and (e) Student–Community (SC). Each item is answered on a four-point Likert scale, with higher scores indicating higher levels of relational risk. The Student–Student dimension, which constitutes the central focus of the present study, comprises three factors: interpersonal relations and social skills (SSt1), educational expectations (SSt2), and belonging/identification (SSt3).

2.4 Analytical Procedures

Analyses were conducted in R software, version 4.4 [17], using the tidyLPA package [18] for latent profile estimation. LPA was conducted using the three factors of the Student–Student dimension (SSt1, SSt2, SSt3) as indicators. Solutions ranging from two to five classes were compared, all estimated under the specification of equal variances between classes and zero covariances (Model 1 of tidyLPA). The selection of the optimal number of classes followed an analytic hierarchy process based on multiple fit indices [1], including AIC, AWE, BIC, CAIC, CLC, KIC, and SABIC, complemented by the examination of entropy, classification probabilities, and the conceptual interpretability of the solutions. The random seed was fixed (set.seed = 2024) to ensure analytic reproducibility.
After selecting the final solution, each participant was assigned to the latent class with the highest posterior probability, and the profiles were labeled as low, medium, and high relational risk, based on the means of the three SSt factors — an ordering justified by the fact that higher IAFREE-A scores indicate greater relational risk. Subsequently, non-parametric Kruskal–Wallis tests were conducted to examine differences between latent classes in the SSt total score and its three factors, as well as in the remaining dimensions of the IAFREE-A (SSc, SSP, SF, SC) and their respective sub-factors. The non-parametric approach was adopted given the ordinal nature of the response scale and the non-normal distribution of the dimensional scores. Effect size was estimated using epsilon-squared (ε^2), with values of .01, .08, and .26 interpreted as small, moderate, and large effects, respectively. Post hoc analyses were performed using Dunn's test with Bonferroni correction for multiple comparisons.

3. Results

3.1 Sample Characterization

The synthetic dataset comprised 10,000 records simulating public school students from four Brazilian states. Regarding gender, the sample was balanced between male (n = 4,898; 49.0%) and female students (n = 5,082; 50.8%), with a small proportion identifying as other (n = 20; 0.2%). Regarding race/ethnicity, the composition reflected the typical profile of Brazilian public schools: 54.9% identified as Brown (*Parda*), 21.7% as White, and 20.6% as Black, with the remaining 2.8% comprising Asian, Indigenous, and undeclared students). Most students reported not engaging in paid work (n = 7,933; 79.3%), while 20.7% indicated current labor participation (n = 2,067). The distribution across socioeconomic strata (INSE) concentrated in the middle levels (strata III to VI accounted for 73.3% of the sample), with smaller proportions in the extreme strata (3.5% combined in I and VIII).

3.2 Selection of the Number of Latent Classes

Table 1 presents the fit indices for solutions ranging from two to five classes. Although models with four and five classes presented progressively lower BIC values, indicating better statistical fit, the three-class solution was selected as the most adequate based on the combination of parsimony, conceptual interpretability, and coherence with the theoretical framework of relational risk, which is traditionally operationalized along three levels (low, medium, and high). The three-class model presented adequate classification quality (entropy = 0.652; minimum classification probability = 0.796), with profiles monotonically ordered along increasing levels of relational risk.

Table 1. Fit indices for solutions from two to five classes (Model 1: equal variances, zero covariances)

Classes	LogLik	AIC	BIC	SABIC	Entropy	Min. Prob.	Max. Prob.
2	−26,692	53,403	53,476	53,444	0.669	0.885	0.913
3	−26,131	52,289	52,390	52,346	0.652	0.796	0.845
4	−25,955	51,946	52,076	52,019	0.758	0.776	0.881
5	−25,734	51,512	51,671	51,601	0.716	0.531	0.894

3.3 Characterization of the Latent Profiles

The three-class solution yielded clearly differentiated profiles, monotonically ordered across the three factors of the SSt dimension. The low-risk profile comprised 30.7% of the sample (n = 3,066), the medium-risk profile 49.7% (n = 4,969), and the high-risk profile 19.6% (n = 1,965). Table 2 presents the means of the SSt total score and its three factors by latent profile.

Table 2. Means of the Student–Student (SSt) dimension and its factors by latent profile

Profile	n (%)	SSt1	SSt2	SSt3	SSt total
Low risk	3,066 (30.7%)	1.42	1.43	1.57	1.47
Medium risk	4,969 (49.7%)	2.25	1.60	2.43	2.09
High risk	1,965 (19.6%)	3.17	1.83	3.19	2.77

The patterns illustrated in Figure 1 reveal monotonic separation between the three profiles, with progressively greater distances between profiles in SSt1 (interpersonal relations) and SSt3 (belonging/identification), while SSt2 (educational expectations) presented a more compressed distribution across profiles.

Figure 1. Latent profile means across the three SSt factors

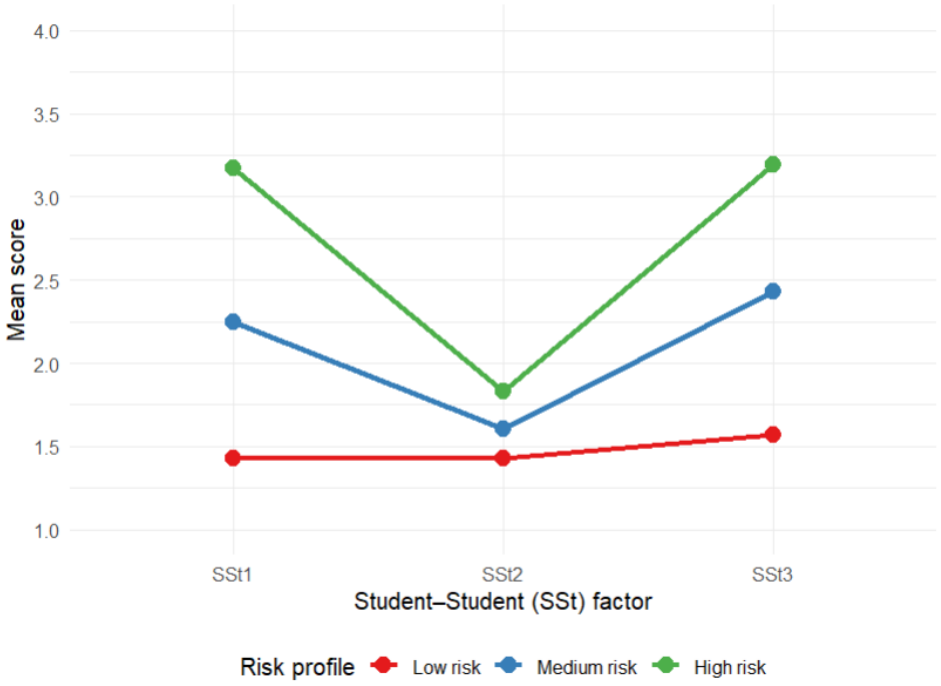


Fig. 1. Line plot of profile means across SSt factors

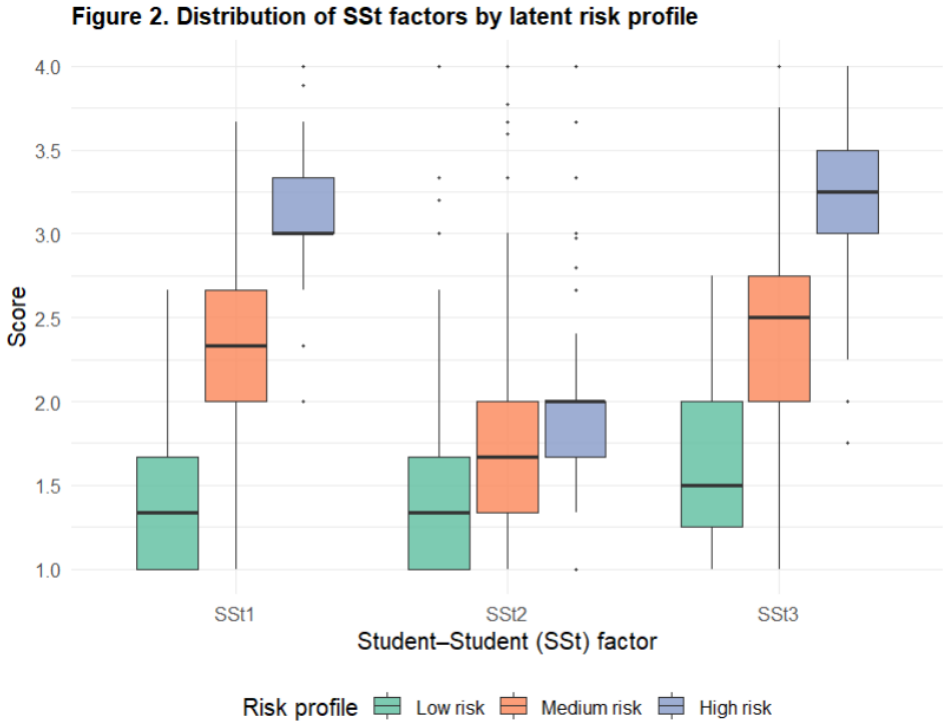


Fig. 2. Boxplot of distributions by profile

3.4 Differences Between Profiles

Kruskal–Wallis tests revealed statistically significant differences between the three latent classes for the SSt total score ($\chi^2(2) = 7{,}702.60$; $p < .001$; $\varepsilon^2 = 0.770$), indicating a very large effect. Differences were also significant and of very large magnitude for SSt1 — interpersonal relations and social skills ($\chi^2(2) = 6{,}870.60$; $p < .001$; $\varepsilon^2 = 0.687$) — and SSt3 — belonging/identification ($\chi^2(2) = 6{,}537.25$; $p < .001$; $\varepsilon^2 = 0.654$). In contrast, SSt2 (educational expectations) presented a significant but smaller effect ($\chi^2(2) = 811.30$; $p < .001$; $\varepsilon^2 = 0.081$). Post hoc Dunn comparisons confirmed significant pairwise differences between all three classes (low vs. medium, medium vs. high, low vs. high; all $p < .001$). The latent profiles also differed significantly across all other dimensions of the IAFREE-A. Table 3 summarizes the results.

Table 3. Kruskal–Wallis tests comparing latent profiles across IAFREE-A dimensions and sub-factors

Dimension / Factor	χ^2	df	p	ε^2
Student–Student total (SSt)	7,702.60	2	< .001	0.770
SSt1 — Interpersonal relations	6,870.60	2	< .001	0.687
SSt2 — Educational expectations	811.30	2	< .001	0.081
SSt3 — Belonging/identification	6,537.25	2	< .001	0.654
Student–School total (SSc)	3,587.85	2	< .001	0.359
SSc2 — Perception of safe school	3,176.01	2	< .001	0.318
Student–School Professionals (SSP)	1,886.85	2	< .001	0.189
Student–Family total (SF)	1,498.63	2	< .001	0.150
Student–Community total (SC)	1,710.22	2	< .001	0.171

The largest effect outside the SSt dimension occurred in Student–School (SSc) ($\varepsilon^2 = 0.359$), particularly in the Perception of the School as a Safe Place factor (SSc2; $\varepsilon^2 = 0.318$). Moderate effects were observed for SSP, SC, and SF. All post hoc Dunn comparisons confirmed significant differences between low, medium, and high risk groups across all dimensions (all $p < .001$).

4. Discussion

The present study identified three monotonically ordered profiles of relational risk (low, medium, and high) and demonstrated that these profiles extend their differentiation to all other relational dimensions of the IAFREE-A, with particularly strong effects in the institutional domain. The identification of three latent profiles with adequate classification quality supports the conceptual premise that relational risk among peers is not uniformly distributed in the student population, but organizes into qualitatively distinct configurations, aligning with process-oriented perspectives that conceptualize school disengagement as a relational and multifactorial phenomenon [10, 22].

The pattern of effect sizes across the three SSt factors revealed an important nuance. Interpersonal relations and social skills ($\varepsilon^2 = 0.687$) and belonging/identification ($\varepsilon^2 = 0.654$) presented very large effects, while educational expectations ($\varepsilon^2 = 0.081$) showed a small effect, suggesting that students' aspirations remain relatively stable across risk profiles. This pattern reinforces the interpretation that relational risk emerges primarily in the affective and interpersonal fabric of school experience rather than in the cognitive domain of aspirations, supporting the conceptual framework of the IAFREE-A [26].

Notably, the latent profiles identified through peer relations extended their differentiation to all other IAFREE-A dimensions, with the largest effect outside the SSt dimension occurring in Student–School ($\varepsilon^2 = 0.359$), particularly in the perception of school as a safe place ($\varepsilon^2 = 0.318$). This convergence indicates that peer-relational risk does not operate in isolation but reverberates into how students experience the school as an institution. Such finding aligns with the broader argument that school trajectories must be understood across multiple interconnected dimensions (systemic, institutional, and individual [11, 24]) and supports the relational model underlying the IAFREE-A [26].

This study has limitations that must be acknowledged. The analyses were conducted on synthetic data generated via the Gaussian Copula technique to comply with the LGPD and to safeguard the identity of participating minors. While this approach preserves the multivariate structure of the original data, it introduces methodological constraints regarding the generalizability of magnitude estimates. Additionally, the cross-sectional design limits causal inferences.

5. Conclusion

The findings indicate that relational risk in school trajectories is organized into three qualitatively distinct profiles, characterized primarily by peer relations and school belonging, while educational expectations remain relatively preserved across risk levels. The extension of these profiles to the institutional domain, particularly to the perception of school as a safe place, supports a process-oriented understanding of school disengagement as a phenomenon that operates simultaneously in interpersonal and institutional dimensions.

Methodologically, the integration of person-centered modeling (LPA) with group-comparison testing on privacy-preserving synthetic data demonstrates the viability of conducting psychometrically rigorous research with minors under LGPD-compliant conditions, offering a pathway for ethically responsible educational research and informing protective interventions focused on the relational fabric of school experience.

Furthermore, large-scale data collection is currently underway for the nationwide application of the IAFREE-A across Brazilian public schools. This ongoing effort will allow future studies to test the replicability of the latent profile structure identified here in empirical, non-synthetic data, expanding the evidence base for the use of relational instruments in early identification of at-risk school trajectories at a national level.

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Development of a Proposal for the Digitalisation of a Support Needs Assessment for Children and Adolescents with Intellectual Disabilities[15]

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Abstract

This study describes the digitalisation of the Supports Intensity Scale – Children's Version (SIS-C), which measures the support needs of children and teenagers aged 5 to 16 with Intellectual and Developmental Disabilities [5] [6]. As part of a broader research project, it aims to adapt the original paper-and-pencil version into a digital alternative while preserving the psychometric integrity established in prior studies. This exploratory study developed a digital model based on data from 801 participants. The process involved key stages: reorganisation and repositioning of variables and response categories; validation by expert judges; interface adaptation; and methodological adjustments to support implementation. Variables were reorganised and repositioned to ensure usability, traceability, and effective data management, including the addition of identification fields tailored to the Brazilian context. Following these modifications, the instrument underwent validation by expert judges in Special Education and Educational Technology. Their feedback informed structural revisions and interface refinements, leading to distinct forms for interviewers, respondents, and participants. Once these revisions were implemented, the instrument was developed into a digital version integrated into a database. Google Workspace tools (Forms and Sheets) were selected for their accessibility, usability, and data management capabilities, providing a cost-free interface. The data from 801 participants were processed in the R statistical environment, ensuring computational accuracy and enabling automated score calculation, reducing manual errors and enhancing reliability. The system also enabled analytical visualisation and longitudinal monitoring, features that were not previously available. The digital version improved application efficiency, analysis speed, and large-scale data management, while preserving conceptual equivalence with the original instrument. The study demonstrates that successful digital adaptation requires validation and contextual redesign, rather than simple format migration. The SIS-C Digital contributes to advancing support needs assessment in Special Education by providing a more efficient tool for data collection, analysis, and interpretation.

Keywords: *Special Education, Intellectual Disability, Supports Intensity Scale, Instrument Digitalisation.*

1. Introduction

In Brazil, according to data from the Brazilian Institute of Geography and Statistics (IBGE), 18.6 million Brazilians aged two or older are considered People with Disabilities (PwD) [1]. In addition, according to the 2023 School Census released by the National Institute for Educational Studies and Research Anísio Teixeira (INEP), there were 952,904 Special Education enrolments in Basic Education of students diagnosed with Intellectual and Developmental Disabilities (IDD) [2].

Although students with IDD represent a significant share of diagnoses in Basic Education, the assessment of IDD has not been an easy task since the 1950s, when it was carried out based on Intelligence Quotient (IQ) tests. Over the years, intelligence tests began to be rethought, and adaptive behaviour assessment instruments started to be developed to support the diagnostic process [3].

In this regard, the *American Association on Intellectual and Developmental Disabilities* (AAIDD) published the first version of the Supports Intensity Scale (SIS) in 2004, intended to assess the intensity

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of supports needed by youths and adults aged 16 and older [4]. At this point, the supports paradigm became central, and the instrument's purpose shifted away from diagnosis toward guiding professional practice and improving the quality of life of individuals with disabilities.
In 2014, AAIDD developed the Supports Intensity Scale – Children's Version (SIS-C), which aims to measure the relative intensity of the support needs of children and adolescents with intellectual and developmental disabilities and developmental delays, between five and 16 years old [5]. The children's version became necessary because "[...] the settings and activities of childhood differ from the settings and activities of adult life" [6].
The SIS-C was validated and adapted to the Brazilian context through the study "Adaptation and Validation of the Supports Intensity Scale for Children and Adolescents (SIS-C) with Intellectual Disability in Brazil" [7]. For this study, the SIS-C was administered in all regions of the country, with a total of 801 administrations [8] completed manually using the printed, paper-and-pencil version of the instrument. The SIS-C was translated and validated for the Brazilian context and, during the establishment of its psychometric parameters, yielded an overall Cronbach's Alpha coefficient of 0.968, indicating excellent internal consistency and item reliability during the establishment of its psychometric parameters, yielded an overall Cronbach's Alpha coefficient of 0.968, indicating excellent internal consistency and item reliability.
The paper-and-pencil version is widely known and is the most common way to complete instruments; however, it can be prone to errors, especially during result generation [9]. This is a problem shared by several instruments that rely on manual entry followed by calculation for analysis, as human error can occur during the calculation process [10].
One strategy to minimise the errors of paper-and-pencil completion is the digitalisation of instruments. Instruments are considered digital when their organisation and administration are carried out by a computer or via the Internet [11]. Although the digitalisation of instruments is not new, the use of technology to automate manual processes continues to grow, especially in the United States and in Europe [9] [12]. In Brazil, where studies began later, growth has been gradual since 2004 [9].
In a literature review conducted on the CAPES Journal Portal (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior) using the Boolean operators "Escala de Intensidade de Apoio" OR "Escala de Intensidade de Suporte" OR "Escala de Intensidade de Apoio - Versão Criança" OR "Escala de Intensidade de Apoio - Versão Adulto" OR "Supports Intensity Scale - Children's Version" OR "Supports Intensity Scale - Adult's Version" AND "Informatização de Instrumentos" OR "Avaliação Informatizada" OR "Computerized instruments" OR "Computerized Assessment" OR "Teste Informatizado" OR "Computerized Test", no studies were found that demonstrated this transition from the paper-and-pencil version to an automated version. Thus, the need to conduct this study to digitalise the SIS-C scale in Brazil was identified.
The digitalisation of psychometric instruments is not a neutral technical process. Research in this area consistently demonstrates that format transitions can affect construct validity, measurement invariance, and response equivalence if not systematically managed [Bugbee, 1996; Mead & Drasgow, 1993]. Mode effects – differences in scores attributable to the medium of administration rather than to the underlying construct – have been documented across cognitive, behavioural, and adaptive scales, particularly when respondent populations include individuals with low digital literacy or atypical cognitive profiles [Cella et al., 2007]. Accordingly, the digitalisation of the SIS-C must be framed not merely as a technological upgrade but as a validity-sensitive psychometric endeavour that requires explicit attention to measurement equivalence, interface accessibility, and procedural fidelity.
Therefore, this study, which is part of a larger study [13], aims to describe the digitalisation process of the Supports Intensity Scale – Children's Version (SIS-C) for children and adolescents aged five to 16 with Intellectual and Developmental Disabilities (IDD).

2. Methods

This study is characterised as quantitative, with a non-experimental, cross-sectional, and exploratory design [14] [15], aimed at developing a digital version of the SIS-C in Brazil.

2.1 Data Source

This study was based on data from the Brazilian adaptation and validation study of the instrument. The SIS-C sample consisted of 801 children and adolescents (five to 16 years old) with IDD, distributed across five Brazilian regions, 20 states, and 120 cities, ensuring broad geographic representativeness of the national territory [8].

2.2 Instrument

The SIS-C is organized as follows: Section 1) Exceptional Medical and Behavioural Support Needs, composed of subscale 1A – Medical and 1B – Behavioural; Section 2) Support Needs Scale, composed of seven subscales: Part 2A Home Living Activities; Part 2B Community Living Activities; Part 2C School Participation Activities; Part 2D School Learning Activities; Part 2E Health and Safety Activities; Part 2F Social Activities; Part 2G Self-Advocacy Activities; and Section 3) Scoring and Profile Form [5]. As already emphasised, this instrument is a standardised assessment tool designed to measure the support needs of a child or adolescent aged five to 16 with IDD to succeed in age-appropriate community settings [8]. Accordingly, the visual presentation of the SIS-C Digital result charts sought to display the scores obtained in Section 1. Exceptional Medical and Behavioural Support Needs, which represent the summary of scores, and the scores obtained in Section 2. Support Needs Scale, which represents the child or adolescent's support needs profile.

2.3 Framework for the Digitalisation of SIS-C:

After the ethical procedures, the digitalisation involved four key stages: Phase 1 – reorganisation and repositioning of variables and response categories; Phase 2 – validation by expert judges; Phase 3 – interface adaptation; and Phase 4 – methodological adjustments to support implementation, as presented in Figure 1.

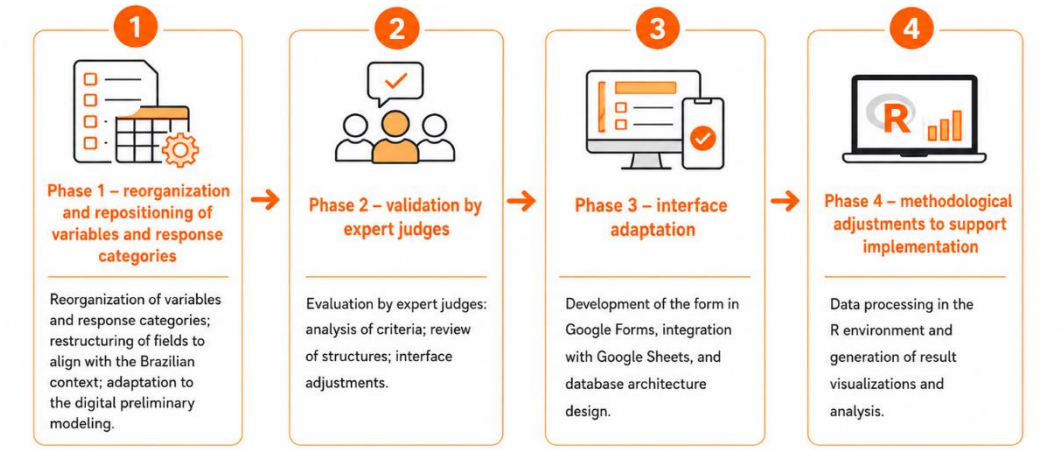


Figure 1. Framework for the digitalisation development of the SIS-C. Developed using ChatGPT.

The selection of expert judges followed purposive sampling criteria based on three conditions: (a) a minimum of five years of active research or professional practice in Special Education or Educational Technology; (b) authorship of at least two peer-reviewed publications relevant to psychometric instrument design, adaptive behaviour assessment, or digital learning systems; and (c) institutional affiliation in Brazil or Portugal, ensuring contextual familiarity with both the source instrument and the target implementation environment. Units receiving 75% or higher agreement were considered priorities for revision. Below this threshold, decisions were made based on technical and conceptual relevance, as assessed by the research team in consultation with the original instrument manual.

2.4 Data Analysis Procedures

To test data entry on the platform, 95% of the source data was used in the digital version. Sequential stages of the data analysis procedure adopted for the SIS-C Digital, illustrating the parallel workflow between platform data entry, automated score processing in R/RStudio, and computational equivalence verification against the original paper-and-pencil dataset.

Data analysis procedures were conducted in parallel with the digitalisation framework (Section 2.3) and with progressive data entry into the platform (Figure 2). A total of 95% of the source dataset (n = 763) was used to test computational fidelity, with raw scores processed in the R statistical environment using RStudio, enabling automated score calculation and normative comparisons based on the age-referenced parameters from Appendices B and C of the SIS-C manual. To verify equivalence, digitally processed scores were compared with the original, manually calculated values using Pearson's

correlation coefficient and mean absolute error, ensuring that no systematic bias was introduced during the format transition.

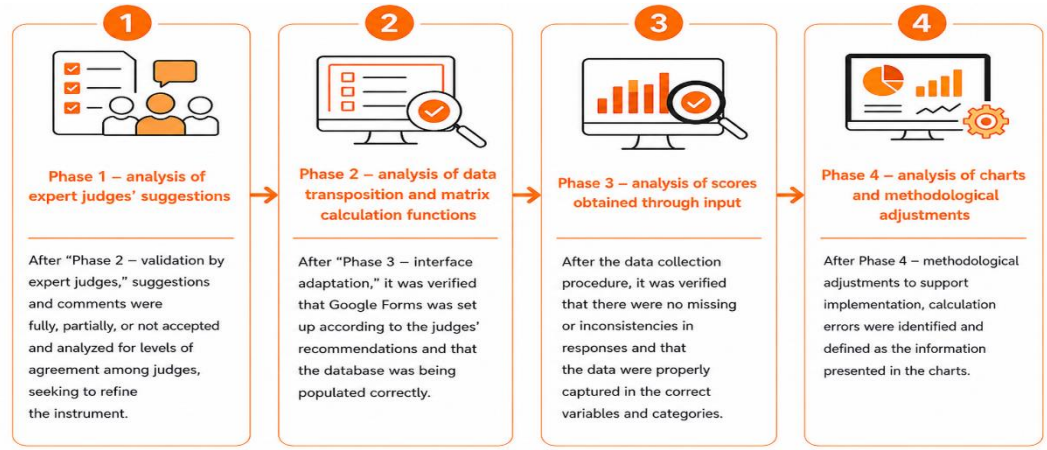


Figure 2. Stages of the Data Analysis Procedure of the SIS-C Digital. Developed using ChatGPT.

3. Results and Discussion

For the development of the digital version of the scale, the variables (general items and adaptive behaviours) and categories (respondents' answers) of the paper-and-pencil SIS-C were tabulated as presented, thus yielding the first digital version, named "SIS-C Digital Scale - Pilot 2021". The same procedure was applied when importing the database of the Brazilian SIS-C adaptation and validation project, which resulted in the second digital version, named "Database - Pilot 2024".

When comparing the two versions, differences were identified, specifically in the variables and categories of the cover sheet related to types of associated diagnosis, kinship, types of residence, and educational stages. This was because the "Database - Pilot 2024" version had incorporated variables and categories derived from the instrument's open-ended items, collected during the validation study administrations. Therefore, the variables and categories of the two versions were merged to be complementary, resulting in the third version, named "SIS-C Digital Scale + Database".

After grouping the variables and categories, the list of the 27 Brazilian states was included to map the geographic distribution of respondents. In addition, new variables were included in the "Associated Diagnosis" field, which was renamed "Primary Diagnosis" and complemented by the "Secondary Diagnosis" variable, while new categories were added to the "Person who provides support" variable.

To facilitate the inclusion or exclusion of variables in future versions, each variable and category, whether open-ended or closed, was coded; that is, a numerical value was assigned to each, as recommended in the literature [15]. As a result of this process, a fourth version was created, named "SIS-C Digital Scale Pre-Equivalence Test".

Once all the information was organised, the platform was selected, and the variables and categories were transposed to *Google Forms*, the platform chosen for the development of the interface and the digital version. It is worth noting that, although *Google Forms* is not a platform designed for psychometric assessments, this interface was chosen because it is free, does not require purchasing a domain, has a simple, intuitive, and well-organised interface, and can generate a storage base in *Google Sheets*.

Once *Google Forms* was created, a visual identity was designed using the colours of the paper-and-pencil version, and the pilot model of the scale was developed and organised into three forms: one for interviewer registration, another for respondent registration, and a third form containing the fields for the "Participant Profile" and Sections 1 and 2 of the Scale.

The pilot model of the SIS-C Digital was then submitted for equivalence review by two judges, one from the field of Special Education (SE) and the other from Educational Technology (ET), from Brazil and Portugal, selected based on their publications in the areas of SE and ET. The judges' comments included suggestions for incorporating certain variables and categories, for the presentation format of variables and categories, and for the organisation of the form. The remarks were discussed, and the suggestions were incorporated, resulting in a fifth version of the scale, named "Expert Judges Version".

The development of a pilot model is an important stage in the instrument development process, as testing the pilot allows comments and revisions to be made and refined based on respondents' contributions [14]. For this reason, it is recommended that the pilot model of an instrument be administered to a sample composed of specialists in the field, such as expert judges. This administration

is intended to evaluate the instrument items and verify whether the categories and variables, as well as their response formats, are understandable and aligned with the proposed objectives, enabling adequate administration to the remaining participants [11].

With the fifth version of the scale, a new form was created in *Google Forms*, structured as a single form, organized into: Section 1 – Interviewer Data; Section 2 – Respondent Data; and Section 3 – Interview and Profile Form – Child or Adolescent Data; subsection 1 – Exceptional Medical Support Needs and Exceptional Behavioural Support Needs; subsection 2 – Support Needs Scale, with its seven subscales. As a result, the "Expert Judges Version" was submitted for validation by eight expert judges, three from the field of SE and five from the field of ET, selected based on their experience and length of work in these areas, whether in SE or ET, in addition to being researchers from Brazil and Portugal.

A total of 52 comments and suggestions were received from the expert judges. Of these, 21 were disregarded as repetitive or as commendations of the proposal. The remaining 31 comments and suggestions were tabulated and grouped into 14 units of analysis according to the type and nature of the comments and suggestions, which were then grouped by semantic proximity into four categories: a) Scale Structure; b) Interviewers; c) Respondents; d) Participant Profile.

Next, the percentage of judges (n = 8) who indicated, in their comments, the need for adjustments in each of these units of analysis was calculated, and they were then classified, regarding the decision to incorporate the suggestions, in three ways: 1) Fully accepted (AI): suggestions and comments that contributed to the clarity, functionality, or appropriateness of the digitalisation; 2) Partially accepted (AP): suggestions and comments that contributed to improving the scale but, to some extent, conflicted with the structure of the original scale, or in which the comments conflicted with each other; 3) Not accepted (NA): suggestions and comments that would alter the structure of the scale and the data, that contradicted what is proposed in the instrument's manual, that fell outside the proposed objective of the validation, or that referred to cultural differences between Brazil and Portugal.

It is worth noting that the decision to incorporate suggestions and comments was not based solely on the percentage (%) of agreement across thematic convergence among the expert judges, but also on their technical relevance and importance for improving the scale, as shown in Table 1.

Table 1. SIS-C Digital validation data by expert judges [13]

Unit of analysis	Category	Type of comments	Agreement %	Classification
1. Layout, legibility and/or formatting adjustments	Scale Structure	Font, text formatting, visual organization, watermark, display	100%	AI
2. Review of administration instructions	Scale Structure	Clarity of instructions, explicitness of procedures	25%	AI
3. Inclusion/adjustment of confidentiality and/or ethics statement	Scale Structure	Consent and confidentiality	25%	NA
4. Numbering and organization of questions	Scale Structure	Numbering of items and blocks	25%	AP
5. Required fields and/or completion validation	Scale Structure	Required fields	50%	AP
6. Review of the scoring key and score presentation	Scale Structure	Calculations and automation of results	37.5%	AI
7. Adjustments to the navigation logic/usability of the digital scale	Scale Structure	Separation of the Form	12.5%	NA
8. Inclusion of an "Other" option	Scale Structure/Profile	Inclusion of the "Other" category in closed fields	87.5%	AI
9. Comments on changing, extending, or shortening the instrument	Scale Structure	Scale length and completion time	25%	NA
10. Adjustments to the professional profile field	Interviewer	Role, position, professional council, interviewer qualifications	50%	AP
11. Adjustments to the respondent/family member profile	Respondent	Kinship, cohabitation, respondent data	25%	AP

12. Review of form terminologies/acronyms	Respondent	Ambiguous acronyms and terminology	25%	NA
13. Adjustments to participants' sociodemographic variables	Profile	Sex/gender, race/ethnicity, states, etc.	25%	AP
14. Criteria for IQ measurement and/or adaptive behavior and eligibility	Profile	Definition and recording of these data	12.5%	NA
15. Inclusion or refinement of information on supports/providers	Profile	Support person, contacts, support	12.5%	AI

It was observed that the contributions of the SE expert judges were more focused on the conceptual fidelity of the scale, the relevance of the variables and categories, and the eligibility and assessed constructs, whereas the contributions of the ET expert judges were more focused on the analysis of platform usability, navigation flow, and system functionalities. After evaluating all units of analysis, the suggestions and comments that were fully or partially accepted were incorporated, culminating in the development of a sixth digital version, named "SIS-C Digital".

The suggestions and comments from the expert judges raise important reflections, since digitalising an instrument requires more than simply migrating from one format to another. The way it is administered must be rethought, as must the format of the variables and categories, requiring a contextual redesign and computational strategies that enhance efficiency, accuracy, and data management. This reinforces the need for instruments to be analysed, discussed, and validated by samples of specialists in the field [16] [11]. The results show that the digitalisation of the SIS-C required not only digital transposition but also the structural reorganisation of the variables, the redefinition of navigation flows, and methodological adaptation to preserve the conceptual equivalence of the scale.

Following the changes, the interface was updated by creating a form in *Google Forms*, and the Database (Matrix) in *Google Sheets* was initiated for data storage. The Matrix was organised according to the layout of the variables and categories of the SIS-C Digital, and the data from the 801 participants were individually transposed to the variables and categories of the final version of the SIS-C Digital. The data were then reviewed to ensure there were no errors or omissions.

Verifying transposed data is important in the digitalisation process because, as a manual procedure, errors can occur. However, such potential errors need to be corrected through individual review of the data and through the appropriate modifications [15].

After analysing the transposed data, methodological adjustments to support implementation were initiated by developing the calculation functions. To this end, a spreadsheet was created to receive data from the Matrix and perform calculations on the raw data, organised by the values of the items in each section of the scale. These data were automatically transferred to a new spreadsheet, and the raw values were submitted to automated operations for summing the scale parts and calculating the mean. Subsequently, the values were directed to specific spreadsheets, organised by age groups (for example, "5-6_y" and "7-8_y"), incorporating the reference values provided in Appendix B and Appendix C of the scale's manual, which, in the paper-and-pencil version, serve to establish the parameters and define the participants' support intensity levels.

This calculation stage, in the paper-and-pencil version, is performed manually in Section 3 "Scoring and Profile Form". However, with digitalisation, this step becomes automated. As a result, this format offers several advantages, such as time savings in data entry and correction, score generation, and result verification, especially in reducing calculation and measurement errors [9] [10].

Upon completing the development of the Matrix's calculation functions, a test was conducted using 95% of the data (n = 763) with the SIS-C Digital to ensure that the data entered remained unchanged. The comparison between manually transposed data and data processed by the SIS-C Digital showed equivalence of results in the analysed database, indicating the stability of the automated calculation functions and the consistency of the computational processing of the data.

One of the main advances observed with the SIS-C Digital concerns the automation of calculations, which is now performed quickly and with a significant reduction in the risk of human error, as reported in the literature. Unlike the paper-and-pencil version, in which calculations must be performed manually, the digital version enables greater accuracy in score generation and optimises the time devoted to correcting and analysing results. These findings corroborate theoretical discussions that highlight one of the main advantages of computerised tests: the computer's ability to score responses without error, quickly and accurately [17]. Likewise, studies indicate that programs and computational resources could contribute to the presentation of statistical results [12].

Once the calculations were completed, programming was carried out in the R system using RStudio, and the development of visual presentations of the result charts to visualise support intensity levels was initiated. The presentation of the SIS-C Digital results was designed to be intuitive, clearly showing the support intensity levels of the child and adolescent, as well as those of other participants in the same age group. These data needed to be understood both by the interviewer and by Education or Health professionals who design educational plans or interventions for the child or adolescent and who could therefore come into contact with the results of the SIS-C Digital, since the information is analysed and produces results that allow understanding the support needs that a child or adolescent requires to live in society with autonomy and independence [18].
For the presentation of scores, following the digitalisation of the scale in the SIS-C Digital, after data *input* and processing in the R system, it became possible to perform calculations automatically and generate chart data in a simpler, more efficient way for analysis.
In the SIS-C Digital, the data is received from Section 1. Exceptional Medical and Behavioural Support Needs are sent to the interviewer's registered e-mail. In the document, the Section 1 scores indicate the behavioural and medical needs items separately, and, for each of them, the items in which the child or adolescent most needs support are presented at the top, following the model of other studies of the scale in which Section 1 scores are organised starting from the highest scores [19].
The data received from the Section 2 Support Needs Scale, as well as those from Section 1, are stored in the Matrix and, once the scale has been completed, are sent to the interviewer's registered e-mail and presented to the interviewer in two ways:
1) Support Needs Profile: the first chart is the support needs profile chart, composed of the *Standard* Score, the Composite *Standard* Score (Support Needs Index), and the Percentile, according to Appendices B and C. In this chart, the age-group means for each part of the scale are represented by columns on the x-axis; alongside, a line indicates each participant's score.
2) Item Scores for each of the Parts: each of the seven subscales is given a chart in which the items for which the children or adolescents most need support are presented at the top, in descending order.
The visualisation of the support needs chart, organised in this way, provides a concise, simple way to view a summary of scores across the seven parts and to indicate which items require greater attention for the child or adolescent [19].
Thus, we can affirm that the results obtained so far [13] show that the digitalisation of the SIS-C preserved the conceptual structure of the original instrument while also improving processing efficiency, reducing operational errors, and enabling new resources for data analysis and visualisation. In addition, the process showed that the digital adaptation of instruments requires methodological validation, structural reorganisation, and computational integration, and is not limited to a simple format migration. The SIS-C Digital now provides a system for monitoring the development of children and adolescents with IDD, as well as longitudinal analysis and continuous assessment, more faithfully reflecting the reality of the Brazilian territory.

4. Conclusions

Finally, this study achieved its proposed objective: to describe the digitalisation process of the Supports Intensity Scale – Children's Version (SIS-C) for children and adolescents aged five to 16 with Intellectual and Developmental Disabilities (IDD). It can be stated that the digitalisation of the SIS-C in Brazil contributed to greater speed in analysis and result generation, as well as to the reduction of human errors, since automated calculations are not subject to typing or mathematical errors and results are now generated.
The results also show that the SIS-C digitalisation process was not limited to migrating the paper-and-pencil version to digital, but also required structural reorganisation, validation by expert judges, and the development of computational strategies and programs, with the aim of preserving the scale's psychometric properties.
In addition, the structure developed for the SIS-C Digital enabled the creation of a data matrix capable of storing historical and longitudinal data on participants' information, enabling different possibilities of analysis regarding the support needs of children and adolescents with intellectual disability throughout the Brazilian territory (allowing different types of analyses).
Another aspect that needs to be highlighted concerns the generation of scores and the presentation of result charts, which facilitate data interpretation by Education and Health professionals and enable the historical and longitudinal monitoring of data by participants in Brazil.
As a limitation of this study, although functional tests and verification of the automated calculations were carried out, the results presented correspond to an initial stage of a broader study. Another limitation is

the limited potential to replicate this study in other countries, because each country needs to work with its own standardised data, that is, statistical values that reflect the reality of that country. Based on these points, future studies may investigate the validity, usability, and reliability of the SIS-C Digital across different application contexts, as well as analyse the potential of the tool for longitudinal monitoring, indicator generation, and decision-making support in educational and clinical contexts.

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From Research Center to Science Museum: Comparative Experiential Engagement Pathways in Informal STEM Learning Environments

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Abstract

This study is part of an ongoing doctoral research project exploring how students experience science when they encounter it outside formal school settings. More specifically, it compares how two informal STEM settings shape students' engagement, emotional response, and sense-making during science-related activities.
To address this research question, a comparative mixed-methods design was developed focusing on two informal STEM settings in Athens, Greece: The National Centre for Scientific Research "Demokritos" and the science and technology exhibition environment Aitherion.
The study combines quantitative data from structured questionnaires with qualitative observations, in order to examine the experience from more than one angle. The research instrument investigated constructs including active participation, experiential learning, emotional engagement, metacognitive awareness, autonomy, science skills, contextual interaction, and future STEM orientation.
A total of 150 secondary education students participated in the comparative phase of the study, including 75 students from Demokritos and 75 students from Aitherion.
Construct reliability analysis demonstrated satisfactory internal consistency for the main analytical constructs used in the comparative analysis, with Cronbach's alpha values ranging from .757 to .910.
Findings suggest that both environments supported highly positive STEM learning experiences, although through different experiential engagement pathways. Demokritos appeared to strengthen perceptions of scientific authenticity and direct engagement with scientific practice, whereas Aitherion appeared to enhance emotional engagement, accessibility, interactivity, and experiential immersion.
Descriptive and comparative analyses showed consistently positive evaluations across the main constructs. Emotional engagement emerged as a particularly important dimension, demonstrating a strong positive relationship with students' overall learning experience ($r = .783$, $p < .001$).
Independent-samples t-tests revealed statistically significant differences between the two environments regarding active participation, experiential learning, and emotional engagement, with higher scores reported in the Aitherion environment.
The findings suggest that informal STEM learning should be understood not only as exposure to scientific content, but as a broader experience involving participation, emotion, context, and students' developing relationship with science. The structure of the data may also allow future work to explore educational analytics approaches in a more systematic way.

Keywords: *Informal STEM learning, Experiential learning, Emotional engagement, Science museums, Research centers, Educational analytics, Science identity*

1. Introduction

In recent decades, informal STEM learning environments have received increasing attention within educational research due to their capacity to enrich students' relationships with science beyond traditional classroom settings. Museums, science exhibitions, research centers, and interactive STEM environments provide opportunities for students to engage with scientific concepts through participation, exploration, and experimentation.
Contemporary science education research increasingly recognizes that meaningful learning extends beyond cognitive achievement alone. Students do not only understand science cognitively, they also respond to it emotionally, socially, and personally.
Within this context, informal STEM learning environments appear particularly suitable for experiential engagement with science. Such environments allow students to interact with scientific ideas in authentic,

participatory, and socially mediated ways that differ substantially from conventional classroom instruction.
The present study explores how different informal STEM ecosystems shape students' engagement with science, emotional involvement, experiential immersion, and future STEM orientation.
The comparative framework focuses on two distinct informal STEM environments in Athens, Greece:

- the National Centre for Scientific Research "Demokritos," representing an authentic research-centered scientific environment,
- and Aitherion, a science and technology exhibition environment emphasizing interactivity and immersive public engagement with science.

The purpose of the comparative design is not to evaluate which environment is "better," but rather to investigate how different informal STEM ecosystems activate different experiential pathways of engagement with science.
More broadly, the study contributes to current discussions on experiential learning, science identity, contextual engagement, and emotional involvement in STEM education. Rather than approaching informal STEM learning as a simple extension of formal instruction, the present research approaches these environments as spaces where students engage with science through experience, interaction, and participation.
The research is situated within a broader doctoral framework investigating how students experience science through informal and experiential educational settings and how these experiences may influence long-term engagement with STEM learning and their later interest in science and STEM-related studies or careers.

2. Theoretical Framework

2.1 Experiential Learning and Informal STEM Education

The study is theoretically grounded in experiential learning approaches, particularly Kolb's Experiential Learning Theory. According to Kolb (1984), learning develops through the transformation of experience via concrete experience, reflective observation, conceptualization, and active experimentation.
Informal STEM environments fit well with this view of learning because they allow students to participate actively, interact directly with scientific phenomena, and connect scientific ideas with personal experiences and meaning-making processes.
Within this perspective, learning is viewed as an active process shaped by experience, participation, and social interaction rather than passive reception of information.
Experiential learning approaches are particularly relevant within science education because scientific understanding is often strengthened when learners interact directly with scientific practices, experimentation, inquiry, and authentic scientific contexts. Informal STEM environments therefore provide important opportunities for students to experience science not only as something explained to them, but as something they can observe, question, and experience directly.

2.2 Contextual Learning and Informal Environments

The research is additionally informed by the Contextual Model of Learning proposed by Falk and Dierking (2016). According to this model, learning in museums and informal environments emerges through the interaction of personal contexts, sociocultural interactions, and the physical environment.
This framework is highly relevant to the present study because Demokritos and Aitherion represent substantially different contextual and experiential learning environments.
Demokritos offers students direct exposure to authentic scientific practice and research culture, whereas Aitherion emphasizes immersive participation, interpretative interaction, accessibility, and visitor-centered experiential engagement.
The contextual dimension of learning is particularly important within informal STEM education because students' experiences are shaped not only by scientific content but also by the broader experiential atmosphere, social interactions, interpretative structures, and emotional dynamics of the learning environment itself.

2.3 Emotional Engagement and Science Identity

Recent STEM education research increasingly emphasizes the importance of emotional engagement and science identity formation. Students' relationships with science appear strongly influenced not only

by conceptual understanding but also by emotional involvement, participation, personal relevance, and feelings of belonging within scientific experiences.
In this study, emotion is treated as part of the learning process itself, not as something external to it. Science identity approaches additionally suggest that students' long-term engagement with science is influenced by whether they perceive themselves as capable participants within scientific practices and scientific culture. Informal STEM environments may therefore contribute to science identity formation by providing opportunities for authentic participation, experiential immersion, and socially meaningful interaction with science.
In the present study, informal STEM learning is approached as a multidimensional experiential process in which participation, emotional involvement, experiential immersion, contextual interaction, and science-related identity development function as interacting dimensions shaping students' relationships with science.
Within this framework, experiential engagement ecosystem refers to the interaction between cognitive, emotional, contextual, participatory, and identity-related dimensions that shape informal STEM experiences.
For this reason, the study does not treat the different dimensions of learning as separate outcomes, but as elements that influence one another during the experience.

3. Methodology

3.1 Research Design

The study adopts a comparative mixed-methods design combining quantitative and qualitative approaches.
The comparative framework focused on two informal STEM learning environments:

- the National Centre for Scientific Research "Demokritos",
- and the science and technology exhibition environment Aitherion.

A mixed-methods approach was used because the study needed both numerical comparison and observational interpretation.
The study combines descriptive statistical analysis, comparative analysis, and interpretative qualitative observations in order to examine how different informal STEM environments shape experiential engagement with science. Observations focused on students' visible participation, interaction with the activities, questions, hesitation, enthusiasm, and use of the physical space.

3.2 Participants

A total of 150 secondary education students participated in the comparative phase of the study.
The comparative sample included:

- 75 students participating in educational activities at Demokritos,
- and 75 students participating in activities at Aitherion.

Participants ranged primarily between 14 and 17 years of age and participated in organized educational visits to the two informal STEM environments.
The sample included students from both Gymnasium and Lyceum educational levels, with representation across both educational levels and genders.
Students completed structured questionnaires immediately following their participation in the activities.
The same questionnaire structure was used across both environments in order to support the comparative framework of the study.
The balanced comparative design was selected in order to support more consistent comparison between the two experiential contexts while maintaining methodological coherence across the analytical sample.

3.3 Research Instrument

The quantitative instrument consisted of parallel structured questionnaires investigating multiple dimensions of informal STEM learning.
The questionnaire explored constructs including:

- active participation,
- experiential learning,
- metacognitive awareness,

- emotional engagement,
- informal learning and autonomy,
- school–museum relationship,
- scientific skills,
- social and cultural context,
- and future STEM orientation.

Example questionnaire items included:

- "I felt enthusiastic during the activity" (emotional engagement),
- "The activity helped me understand how science works in real life" (scientific authenticity) and
- "I would like to participate in similar STEM activities in the future" (future STEM orientation).

Responses were collected using Likert-type scales ranging from 0 to 10.
Construct reliability analysis demonstrated satisfactory internal consistency for the main analytical constructs used in the comparative analysis. Cronbach's alpha values ranged from .757 to .910 for the primary multi-item scales, including active participation (α = .850), experiential learning (α = .835), emotional engagement (α = .910), and future STEM orientation (α = .757).
Qualitative observations were additionally used to support the interpretation of students' experiential responses within the two environments.

3.4 Data Analysis

The analysis included:

- descriptive statistics,
- construct reliability analysis,
- independent-samples t-tests,
- effect size analysis using Cohen's d,
- correlation analysis among the main experiential constructs.

Welch independent-samples t-tests were used due to variance differences observed between groups across some constructs.
Statistical analyses and reliability analyses were conducted using RStudio (R version 4.2.2).
The analysis also considers how different experiential dimensions relate to one another, which may inform future educational analytics work.
Although the present paper focuses primarily on descriptive and comparative analysis, the structure of the dataset may support future work on learner engagement profiles.

4. Findings

4.1 Overall Positive STEM Learning Experience

Findings indicated that both environments supported highly positive informal STEM learning experiences. Students in both Demokritos and Aitherion reported strong levels of participation, engagement, and experiential involvement.
Descriptive analysis showed consistently positive evaluations across the main constructs of the questionnaire. Emotional engagement and overall experience emerged among the strongest dimensions of the learning experience.
Overall, the results indicate that informal STEM environments may operate as meaningful complementary spaces for science learning beyond the classroom. The learning context itself therefore appears to matter.

4.2 Different Experiential Pathways

Although both environments produced positive learning experiences, important experiential differences emerged.
The Demokritos environment appeared to strengthen perceptions of scientific authenticity, direct exposure to scientific research, and students' understanding of science as a real research process.
In contrast, Aitherion appeared to emphasize emotional engagement, accessibility, interactivity, and experiential immersion.
Table 1 presents comparative descriptive statistics for the main experiential constructs across the two environments.

Table 1. Comparative descriptive statistics across the two informal STEM environments

Construct	Demokritos (M ± SD)	Aitherion (M ± SD)	t(df)	p	Cohen's d
Active Participation	6.773333 ± 2.64	7.70 ± 1.83	-2.4911 (131.63)	.01398	0.4121
Experiential Learning	7.644444 ± 2.30	8.30 ± 1.55	-2.0499 (129.86)	.04238	0.3348
Emotional Engagement	7.448889 ± 2.58	8.34 ± 1.65	-2.5237 (126.06)	.01286	0.4121
Future STEM Orientation	7.302222 ± 2.25	7.56 ± 2.17	-0.7263 (147.82)	.46880	0.1200
Overall Experience	7.893333 ± 2.21	8.47 ± 1.77	-1.7528 (141.38)	.08181	0.2900

The analysis revealed statistically significant differences regarding active participation, experiential learning, and emotional engagement, with students in the Aitherion environment reporting higher scores across these dimensions.
The effect sizes observed across these dimensions were small to moderate, suggesting meaningful experiential differences between the two environments without implying absolute superiority of one context over the other.
However, differences regarding future STEM orientation and overall experience did not reach statistical significance.

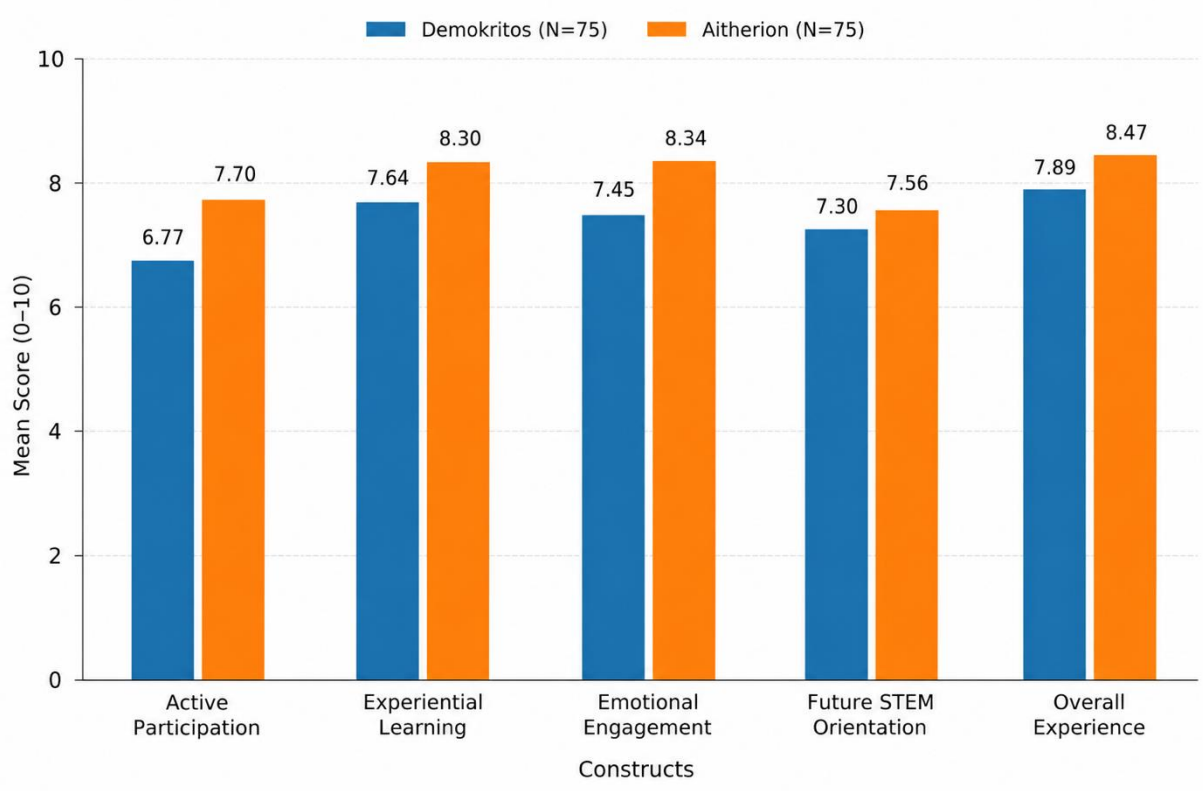


Fig. 1. Comparative experiential profiles of Demokritos and Aitherion across the main constructs of informal STEM learning.

The comparative findings suggest that the two environments supported engagement in different ways. These findings suggest that informal STEM environments may operate through different experiential mechanisms, with some environments emphasizing scientific authenticity and research culture, while others emphasize immersion, accessibility, and emotional participation.

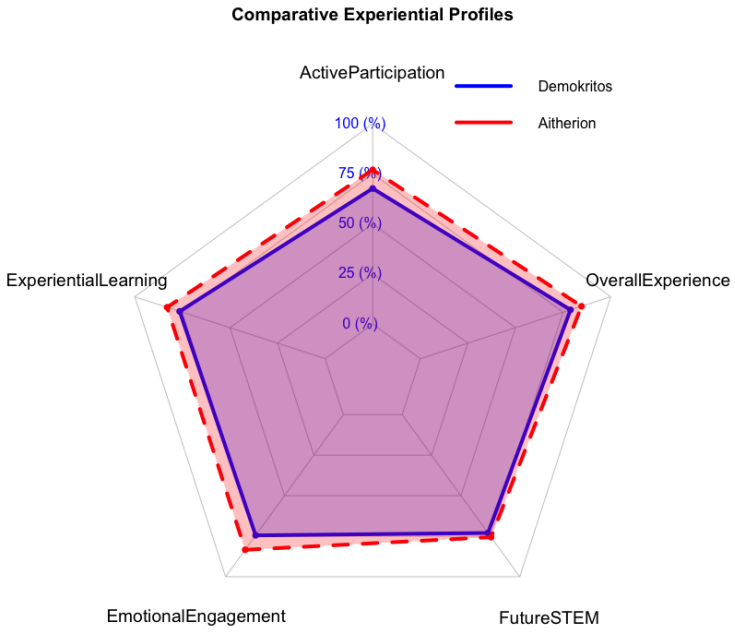


Fig. 2. Comparative experiential engagement profiles across the two informal STEM learning environments.

4.3 Emotional Engagement as a Central Experiential Mechanism

One of the most important findings of the study concerns the role of emotional engagement.
Students reporting higher levels of enthusiasm, personal involvement, and emotional connection with the activities also tended to report more positive overall learning experiences.
Correlation analysis demonstrated a strong positive relationship between emotional engagement and overall learning experience ($r = .783$, $p < .001$), suggesting that emotional involvement functions as one of the main ways through which students came to value the experience.
Taken together, the results highlight the importance of participation and emotional involvement within informal STEM learning experiences, rather than viewing learning simply as knowledge transmission.
The strength of the observed relationship additionally suggests that students' emotional experiences within informal STEM environments may play a particularly important role in shaping how students evaluate, remember, and relate to science experiences more broadly.
The comparative results show that informal STEM learning cannot be reduced to a single model of student engagement.

5. Discussion

The findings contribute to current discussions concerning experiential learning and student engagement within informal STEM education.
A central observation from the comparative analysis is that the two environments supported engagement through different mechanisms. In this sense, different environments appear to activate different experiential pathways of engagement with science.
Demokritos emphasizes scientific authenticity and direct interaction with research culture, whereas Aitherion strengthens emotional engagement, immersive participation, and interpretative interaction with scientific ideas.
Importantly, however, both environments appear capable of supporting meaningful science engagement.
These observations align closely with experiential learning approaches and the Contextual Model of Learning proposed by Falk and Dierking. Learning appears to emerge not only through cognitive

processing but also through emotional involvement, participation, contextual interaction, and experiential immersion.
Perhaps the most notable finding concerns the role of emotional engagement. Students' relationships with science appear strongly influenced by whether they experience science as emotionally meaningful, participatory, and personally relevant.
Emotional engagement also appeared to connect participation, contextual immersion, and students' future orientation toward STEM learning.
The findings suggest that students' informal STEM experiences are shaped by multiple interacting dimensions. These include understanding, participation, emotional involvement, the structure of the setting, and students' sense of belonging within science-related activities.
In practice, this means that informal STEM environments may influence students not only cognitively, but also emotionally and socially through participation, immersion, and identity-related experiences.

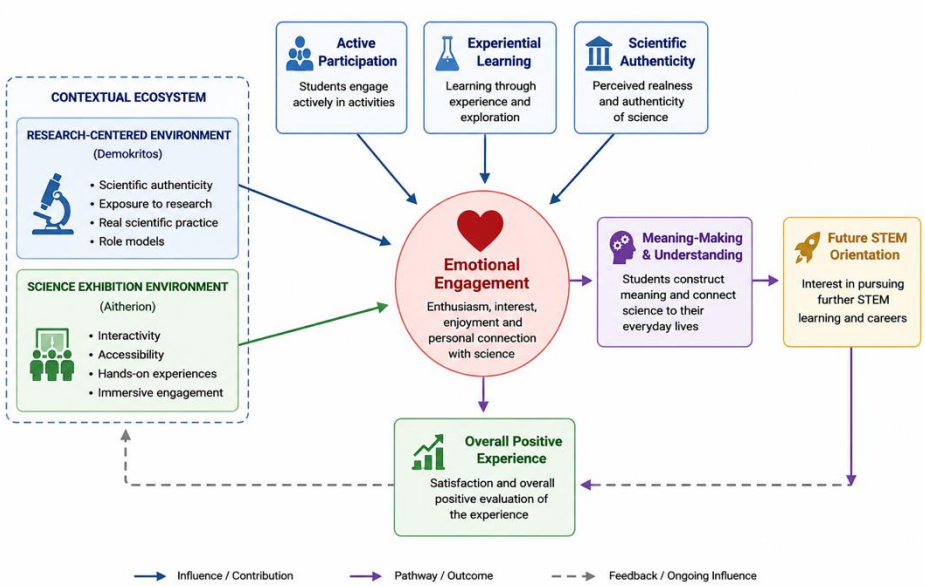


Fig. 3. Conceptual model of experiential engagement pathways in informal STEM learning environments.

At the same time, several methodological limitations should be acknowledged. First, the study relies primarily on self-report questionnaires completed immediately following participation in the activities, which may increase the influence of recency effects and social desirability bias. Second, the study did not include pre-visit measurements, limiting the possibility of examining changes in students' attitudes before and after participation. In addition, the research focuses primarily on short-term experiential responses and does not investigate the long-term sustainability of STEM engagement over time.
Finally, the comparative framework is based on two informal STEM environments located in Athens, Greece, limiting broader generalizability.
Future studies may additionally explore explainable predictive approaches, such as learner engagement profiling and decision-tree modeling, in order to investigate how experiential dimensions predict future STEM orientation across different informal learning environments.
The multidimensional structure of the present findings may additionally support future applications of educational analytics and explainable predictive modeling within informal STEM education research.
The findings may additionally support educators, museum designers, and informal STEM learning practitioners in designing experiential science activities that strengthen emotional engagement, participation, contextual immersion, and students' long-term relationships with science.
Despite these limitations, the study provides an important exploratory framework for understanding experiential engagement within informal STEM education.

6. Conclusions

The present study investigated how students experience science across two different informal STEM learning environments: a research-centered scientific environment and a science exhibition environment.

The findings suggest that both environments support meaningful STEM learning experiences, although through different experiential mechanisms.
Demokritos appears to strengthen perceptions of scientific authenticity and direct interaction with research culture, whereas Aitherion enhances emotional engagement, immersive participation, and experiential accessibility.
The study additionally highlights the central role of emotional engagement within informal STEM learning. Students seem to value these experiences more strongly when they feel involved, not only informed.
Overall, the findings highlight the multidimensional nature of informal STEM learning, where cognitive, emotional, contextual, and participatory dimensions continuously interact during the learning experience.
The study therefore offers a comparative framework for understanding how different informal STEM settings can support students' relationship with science in distinct but complementary ways.

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Teacher Professional Development

Three Models to Address the Global Teacher Shortage: What School Leaders Must Do to Create Sustainable Pathways that Grow Well-Prepared and Diverse Teachers

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Abstract

A global teacher shortage has presented schools and school leaders with an unexpected barrier to success in their efforts to recover learning loss and generate meaningful academic gains after the COVID-19 pandemic. The high number of teacher vacancies requires an innovative and coordinated response from school leaders and teacher preparation programs to ensure a qualified and diverse teacher workforce now and in the future. This paper explores three models initiated by Marywood University in collaboration with its school partners to expand the teacher pipeline, recruit and retain highly qualified teachers, and address a growing need for diversity in the teaching profession. Those models include a grow-your-own (GYO) program for high school students, alternative routes to certification for aspiring paraprofessional educators, and an accelerated pathway for adult learners seeking initial or secondary teaching certifications. Together, the University and its partners have responded to the needs of the workforce and created sustainable practices to diversify and stabilize the local labor market. In combination with emerging literature on teacher preparation, these models provide a foundation for best practices that can be used to produce similar results in a variety of settings, including international contexts.

Beyond recounting successes and comparative analysis, this paper calls on school leaders to embrace their role in developing innovative, sustainable, and ethical teacher preparation programs that are capable of filling teacher vacancies in the modern era.

Keywords: *Teacher Shortage, Grow-Your-Own (GYO), Alternative Route, Accelerated Pathways, School Leadership, Teacher Preparation*

1. Introduction

Teacher quality matters. More than any other tool or resource that can affect student success, the single most important factor that influences student learning is the quality of the teacher who designs, delivers, and assesses their progress (Darling-Hammond, L., & Young, P., 2002). Ministries of education, state departments, and school leaders have focused on this vital element in the classroom for years in an effort to improve student outcomes and increase accountability (Danielson, C. 2016; The New Teacher Project, 2009), but before the quality of teaching can be assessed in a classroom, there must first be a highly qualified teacher assigned to it.

Teacher shortages have garnered attention in the five years that elapsed since the global pandemic (Miller et al., 2019; Rice et al., 2024; Pitt, 2025; Sparks, 2025). But a diminished supply of qualified teachers affected schools long before COVID-19 (McKibben, 2025; Partelow, L., 2019; Schmitt, J., & deCourcy, K., 2022). This is especially true in specific content areas such as math, science, and special education (Day, J., & Nagro, S., 2025; Rice et al., 2024). Poor working conditions and overall compensation are generally recognized barriers to a sustainable teacher pipeline (Sparks, 2025), with some further noting particular difficulty filling vacant positions in rural areas, urban schools, (Carl, B. & Seelig, J., 2025; McClure, C., & Reeves, 2004; Miller et al., 2019) and in communities with compounding socioeconomic challenges (Bianco, M. & Marin-Paris, D., 2019; Goings et al., 2018; Research for Action, 2025).

Recognizing the importance of establishing and maintaining a sustainable teacher pipeline, state agencies have supported Alternate Route Teacher Certification (ARTC), designed to increase the number of qualified and certificated teacher applicants by reducing barriers to entry into the teaching profession. Such efforts have focused on providing financial support for alternative route programs, incentivizing continuous service for teachers certified through them, and addressing general working conditions for all teachers through leadership training and professional development (Miller et al., 2019; National Education Association, 2020; Pitt, 2024). While much is documented about the effort to recruit

candidates to alternate route programs, there is considerably less attention given to best practices and the sustainability of ARTC programs in the literature. The aim of this paper is to describe themes that emerged from a comprehensive literature review on alternative route teaching certification programs in order to compare them with programs under development at Marywood University in the United States of America, and inform others who are similarly tasked with designing alternate route programs in response to a diminished supply of qualified teachers.

2. Methodology

A narrative review was used to explore and explain phenomena expressed to the authors by local school leaders from twenty public and private schools. Sources were first identified by themes expressed over a two-year period of on-site visits and professional events with K-12 school leaders. Thematic and content analyses were applied to the initial search terms. Chronologic order provided a final search strategy that was initially delimited to a five-year post-pandemic window. Older sources were then identified through spiralization.
No formal risk of bias assessment was employed, though the author's independent research served as a mitigating factor for inherent bias.

3. Research Questions

The research questions that guided this paper were:

1. How do alternative route teaching preparation programs structure themselves to serve the needs of teacher candidates, particularly those in high-need areas, to increase supply to the local teacher labor markets?
2. What can educational leaders do to ensure their alternate route programs align with established best practices and position ARTC teachers for sustained success in teaching?

4. Literature Review

Alternate pathway programs vary from state to state in the US but are generally described as programs that recruit cohorts of students to obtain a state teaching license through an accelerated pathway that reduces barriers that might dissuade future teacher candidates from teaching (Blazar et al., 2026; Day, J., & Nagro, S. 2025). The two primary models found in the literature include pre- and post-baccalaureate alternate route teacher certification programs and community-rooted "Grow Your Own" models. Pre- and post- baccalaureate programs recruit prospective teachers from adjacent fields into teaching, while Grow Your Own programs are designed for high school students and/or community members already employed or engaged in the schools without teaching credentials.
Alternate Route Teacher Certification (ARTC) programs have become a vital resource for school leaders in responding to global and localized teacher shortages (Day, J., & Nagro, S., 2025; Garcia, 2024; Miller et al., 2019; National Education Association, 2020; Research for Action, 2025; Pitt, 2024). By relieving teacher candidates of common barriers to entry into the profession and placing greater emphasis on real-world classroom training over a traditional approach to teacher preparation (Garcia, 2024; Hamman et al., 2023; National Academy of Education, 2024; National Education Association, 2020), ARTC programs reduce the delta between pre-service training and full-time employment as a teacher**.** In doing so, they not only increase the supply of qualified teachers they also demonstrate the potential to increase diversity and reduce teacher attrition (Hamman, D. 2023; McKibben, S. 2025) that can exacerbate teacher supply problems.
There is great evidence to suggest that alternate route programs have led to an increase in teacher certifications, particularly for areas with the greatest need (Hamman et al., 2023; PA Dept. of Ed, 2025; Research for Action, 2025). Examining their own alternate route program outcomes, Miller et al. (2024) recounted early success not only in recruiting candidates to the teaching profession through their ARTC program but also in job placement. "Over the course of the past five years, 154 participants have started our [alternate route] program, and 113 have been hired and placed as teachers of record, which is an average of 22 new teachers each year. [...] Statewide, alternative IHE-based teacher preparation program completers made up 26%-30% of the teacher education completers from 2012 to 2016 (p. 5)."
Citing data from the 2021 US Bureau of Labor Statistics, Day and Nagro (2025) similarly reported that nearly 20% of all newly certified teachers entering the workforce in the United States came from alternate route programs (p. 739).

In Pennsylvania alone, over 100 students were reported “on track” to become certified special education teachers through an Accelerated Special Education Teacher Certification program offered by 14 colleges and universities throughout the Commonwealth (Pennsylvania Department of Education, 2025). That represented nearly 15% of all new special education instructional I certificates from 2023-2024 (Pennsylvania Department of Education, n.d.).
Together, these reports indicate that higher education leaders need to design ARTC programs for an average of one out of every five certified teachers, a number that may increase due to early retirements and natural attrition.
With this in mind, the authors investigated how alternative route teacher certification programs were evolving to meet the needs of teacher candidates, particularly those in high-need areas. The research objective was to learn best practices that can be used to increase teacher supply and ensure ARTC teachers are positioned for sustained success. The themes chosen by the authors relate to the design of ARTC programs, the recruitment of teacher candidates, the delivery of instruction, and the overall sustainability of those programs.

4.1 Provide Multiple Pathways

The first theme found in the literature was the wide variety of ARTC programs themselves. “While most states permit them, AR preparation programs are difficult to define due to their vast models of requirements, implementation, and participants (Day & Nagro, 2025, p. 738).” No singular ARTC model for either pre- or post-baccalaureate programming presented a clear advantage in terms of teacher recruitment or outcomes, but all demonstrated promise in fulfilling their goals. Therefore, ARTC Programs that offer multiple pathways, including alternative route programs for adults, paraeducators, and high school students, will invariably serve a broader range of future teachers than those that limit themselves to one specific model. A multi-tiered approach to alternative certification was also shown to increase diversity among alternate route certified teachers. “Much of the research examining the different pipelines used to recruit teachers of color ultimately finds that ‘Grow Your Own’ *and [emphasis added]* residency programs are most successful in recruiting teachers of color (Carter, 2021, p. 2).”
The potential for diversifying teacher candidates through multiple ARTC pathways was supported by McClure and Reeves as early as 2004. Attracting “those who have the interest and potential but lack education credentials and certification [including] secondary school students, community college students, education paraprofessionals, substitute teachers, and professionals in other fields - will require states to develop career pathways that accommodate the particular needs of nontraditional students, including financial aid (p. 16).”

4.2 Meet Future Teachers Where They Are

Preparing pre-service teachers with real-world classroom experience through ARTC programs was a core component of both adult teacher training programs and Grow Your Own models. In many ARTC models, classroom experience was used to supplement, or even replace, traditional lecture-based classes. Such job-embedded training serves as a tool for affirmation, validation, and re-recruitment of ARTC teachers, while providing valuable experience, but it required changes to traditional preparation to be successful. A number of programs moved away from in-person instruction entirely, opting for online modalities, rather than in-person classes for ARTC students.
Online instruction was also shown to remove the barrier of proximity to campuses. The need to “meet the students where they are at” or, in this case, meet the *future teachers* where they are at, was expressed to the authors and emphasized in the literature. This phrase has become commonplace in K-12 classrooms in the post-pandemic era, emphasizing the importance of understanding student readiness and designed instruction scaffolds learners toward instructional goals. Similarly, ARTC candidates must be met where and when they are able. The online modality was frequently cited as the preferred method for flexible ARTC instructional delivery. “One way to address teacher shortages in rural areas is to offer quality alternate route degree programs through an online delivery system, which can overcome the barrier of proximity to a campus or program (Miller et al., 2025, p. 2).”
Shifting to online instruction can be a significant challenge. It is presented throughout the literature as a necessary first step, however, to reducing barriers for alternative route teachers and one that has the greatest potential for sustainability.

4.3 Cultivate Partnerships

Practitioners with whom we worked frequently shared how rapidly the field of teaching had evolved in the years that followed the COVID-19 pandemic leading to teacher burnout and increased attrition. In response, most suggested the need for collaborative efforts and partnerships between schools, colleges and universities, community leaders, and policy makers. “The data is clear: If Pennsylvania hopes to be an educational and economic leader in the future, then recruiting and retaining a skilled and diverse teacher workforce must be a top priority of policymakers (Boyce & Morton, 2023, p.7).”
Local organizations such as PA Needs Teachers have initiated public relations campaigns to address what they say is a teacher shortage crisis that threatens student achievement and the prosperity of the Commonwealth of Pennsylvania. “If we want our kids to be equipped to achieve their dreams and our economy to thrive, it’s simple: PA needs teachers (PA Needs Teachers, n.d.). Similar calls for cooperation among state and local agencies were presented in Blazar et al. (2026), Hamman & Nguyen (2023), and Miller and others (2019).
The recent focus on teacher shortages is not limited to a specific region of the United States, however. It is a national problem that can be addressed through strategic partnerships between school districts, universities, and community organizations. A variety of state-wide reports suggest that coordinated responses have begun; however, more work remains. With this in mind, we frame the discussion of the literature around a case study of ARTC programs at Marywood University in Scranton, Pennsylvania, United States of America.

5. Case Study Discussion

5.1 Multiple Pathways to ARTC

One of the strongest correlations between the literature and the implementation of programs at Marywood University was the importance of offering multiple pathways into the teaching profession. Rather than focusing on a single certification model, the School of Education introduced and developed several ARTC programs. The pathways include a Grow Your Own (GYO) partnership with a local school district, an Early Childhood Education pathway through a Career and Technical Center, and a Paraeducator program with a local education agency. Modifications to the University’s existing Master of Arts in Teaching (MAT) program were also made to reflect the ARTC pathway programs and reduce barriers to entry into the profession for post-baccalaureate students. Each pathway opened the door for students who may not have considered teacher certification through a traditional process.
Conversations with prospective students revealed that beginning or returning to a traditional teacher certification program felt too rigid and often did not align with the realities of ARTC students’ lives, which included full-time employment, caregiving responsibilities, financial commitments, and personal obligations. These pathways were created to provide opportunities for certification to students who previously believed none existed. Flexible online coursework, part-time enrollment programs, reduced tuition costs, and evening and weekend sessions made certification possible for them.
In addition to increasing enrollment, these pathways attracted a more diverse applicant pool, including candidates from a broader range of racial, cultural, socioeconomic, and professional backgrounds. Many students were already connected to their local school through roles such as paraprofessionals, substitute teachers, and classroom aides, which reinforced the benefit of culturally relevant teaching.

5.2 Recruiting ARTC Candidates

Another finding was the importance of relationship-based recruitment efforts and individualized student support through personalized advisement. “Recruiting for the program was not a one-time event [...]. We constantly evaluated our various recruiting strategies [and] recommend that programs designate personnel to be responsible for monitoring recruitment efforts to ascertain that programs are effectively expending their efforts and resources (Miller et al., 2019, p. 13).” Faculty and staff at Marywood made a commitment to meet potential candidates in the field rather than to rely on traditional recruitment through general marketing. That allowed the University to better understand the needs of local schools and create pathways that were more likely to benefit teacher candidates. Faculty advisors then worked closely with students to customize a schedule that took their personal responsibilities, financial resources, work commitments, and long-term professional goals into consideration. Our experience was consistent with Miller and others (2019) in a post-pandemic setting.

5.3 Meeting Them Where They Are

Meeting students "where they are" required changes in modality, course offerings, and master scheduling for the University. The evolution of the program was not always comfortable for faculty and part-time instructors, but the focus quickly shifted to making the online learning space as engaging and supportive as possible so students did not feel as though they were teaching themselves. This required a blend of synchronous and asynchronous classes, redesigning course assignments and assessments to match the modality, and an ongoing commitment to making the coursework relevant, meaningful, and engaging. The program also added course sections and offered coursework outside of normal sequences to ensure that courses were available when students needed to take them. This flexibility helped students stay motivated and served as an important re-recruitment and retention tool by preventing semesters of inactivity.

5.4 Importance of Online Modality and Field Experience

There is no doubt that many faculty still prefer in-person learning experiences for preparing future educators. However, the program recognized that traditional on-campus instruction posed a significant barrier to the ARTC pathways, as described in the literature. This was equally true for high school students who are required to attend school, paraeducators employed by schools and bound by defined operational hours, and post-baccalaureate students with full-time jobs and/or family responsibilities. As a result, the ARTC programs at Marywood adopted a blended approach to online learning and retooled course activities and assessments to better align with an online modality. The flexibility created opportunities for students to pursue certification without sacrificing employment or other responsibilities. More importantly, a shift to online learning preserved and emphasized real-world classroom experiences and job-embedded learning. Students in the Grow Your Own (GYO) program spend up to a full class period each day working with younger students and master teachers to observe and apply basic elements of lesson planning and instructional support. The paraeducator pathway recognizes that paraeducators have daily access to classrooms, students, and experienced teachers and strengthens their experience by providing additional layers of support from faculty, field supervisors, and a structured scope and sequence of applied learning opportunities that deepen understanding of curriculum and pedagogy in their school setting.

5.5 The Role of Partnerships

The redevelopment and continued growth of the SOE's ARTC programs would not have been possible without the cooperation and genuine collaborative efforts of local school districts, school leaders, and community partners. The School of Education made a concerted effort to work directly with educators in their school communities off-campus. In turn, school leaders and community partners opened their doors and worked collaboratively with the University to identify certification pathways that could address staffing shortages without significantly disrupting the school schedule and staffing. Each partner school and school leader played an essential role in creating, redefining, and sustaining the ARTC pathways. These partnerships provided valuable insight into constantly changing workforce needs, local challenges, and the types of support necessary for future teachers to be successful.

School leaders were essential personnel who identified ARTC candidates already working within their schools as substitute teachers, paraprofessionals, or support staff, and encouraged them to pursue certification through an alternative pathway aligned to their needs. As a result, the ARTC programs expanded access to the teaching profession while supporting local schools in addressing staffing shortages in the areas of greatest need, particularly rural and urban schools and more generally, special education classrooms. Efforts are now underway to recruit additional candidates for math and science certifications which remain difficult to fill.

Through the ARTC pathways, enrollment in the School of Education at Marywood increased 45% in three years. These results suggest that partnerships between universities, school districts, and community organizations are, in fact, essential for developing sustainable and responsive teacher preparation pathways capable of addressing the ongoing challenges caused by teacher shortages.

6. Limitations

There were several limitations to this literature review and case study. First, the research was limited to themes expressed to the authors of this paper in K-12 settings in the United States. It relied heavily on

available literature published in the past five years (2021-2026) and used spiralization to identify earlier work that might inform best practices. A comprehensive review of the literature dating back to the origin of alternative teacher certification programs may yield different results. The same can be said for the inclusion of literature focused on international schools.
The discussion of the case study is similarly limited to one small private university in Northeastern Pennsylvania, United States, and may not be reflective of a broader sample of colleges and universities that offer ARTC programs, both domestically and abroad.

7. Implications and Conclusion

This paper presented the changing needs of ARTC programs. Those needs are most relevant to anyone working in a higher education leadership position with teacher training programs. The paper stressed the importance higher education leaders working closely with their K-12 counterparts to respond to current teacher shortages. In doing so, we must also recognize the changing needs of K-12 school leadership.
Principals, supervisors, and superintendents will need to commit to the recruitment and retention of a fully qualified and diverse staff in a way that may not have been addressed in their leadership training programs. Graduate leadership programs should be willing to offer support and training designed for new challenges in K-12 leadership.
Our conversations with K-12 school leaders led to the realization that modifications to our own graduate-level leadership training program were necessary. Closer attention to applied leadership styles that reduce teacher attrition, improve working conditions and school climate, and support a greater understanding of labor relations were prioritized over management theory.
In making those adjustments, students' confidence in their ability to resolve complex problems of practice that lead to teacher shortages increased. Interest grew in the program resulting in higher enrollments and greater diversity of leadership candidates over the past two years. The redesign also led to the creation of a new degree at the University - a Doctor of Education in Educational Leadership – that is focused on leading "in the new normal." The Ed.D. in Educational Leadership has now expanded to an international market for teacher-leaders and school administrators around the world leading to greater learning experiences and preparation of leadership candidates.
In summary, the themes presented in the Alternate Route Teacher Certification research were able to be directly applied to school leadership: in order to prepare the next generation of highly qualified educators *and educational leaders,* we must provide multiple pathways that reduce barriers to entry, meet aspiring educators and educational leaders where they are at, and maintain collaborative relationships between K-12 schools and certification programs, in order to resolve shortages now and in the future.

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The Landscape of Becoming a Science Teacher: A Case Study on Professional Identity, Inquiry and Emotions in Preservice Teachers' Education

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Abstract

In recent years, teaching identity has emerged as a growing research area in science education, considering its impact on students' performance. This study explores the interrelationships between teacher identity construction, inquiry orientation, and emotional experiences of Physics and Chemistry preservice teachers during their initial teacher education. We performed a multidimensional analysis using a case-study approach and validated instruments, such as the pre-service teachers' IBSE perception (PTIT) questionnaire for inquiry perception and the Professional Practice and Inquiry (PPI) questionnaire for identity perception. Results revealed that pre-service teachers generally recognised the value of inquiry-based approaches for students, experienced predominantly positive emotions during training, and had difficulty in establishing past-present connections, likely due to limited teaching experience. The study found that high teaching identity scores on the PPI questionnaire did not necessarily correlate with inquiry orientation. At the same time, positive emotions were observed across different profiles, suggesting that becoming a science teacher follows individualized pathways. Consequently, this research highlights the importance of integrating identity, inquiry, and emotions into teacher education programs and of designing personalised approaches to support diverse developmental trajectories while maintaining high professional standards.

Keywords: *Pre-service teachers, teacher identity, inquiry-based science education, emotions*

1. Theoretical Framework

Research on the construction and development of teaching identity has recently sparked a growing interest in science education due to its influence on the development of teaching strategies and its direct impact on student learning. [1]. Determined by contextual and personal factors and with a dynamic and multidimensional nature, which evolves hand in hand with professional development [2], it refers to the self-concept or central image constructed from experiences, beliefs, and values, personal and practical practices that shape teaching actions.

In Secondary Education, pre-service teachers (PSTs) also face a duality between their identity as students and their identity as science teachers, giving rise to difficulties during teacher education programs. These difficulties are mostly related to the change in professional identity, the teaching model they aspire to, and their previous professional experience [3].

On the one hand, the construction of the teaching identity closely relates to PSTs' research capacity, not only to the skills to teach students through a research approach but also to the ability to address philosophies and ways of interacting within an educational community that values and practices science and technology through inquiry, being able to deliberate reflection aimed to focus on problem posing [4]. By inquiring and examining their understanding of teaching, PSTs question, think, discuss, and further increase awareness of their understandings, values, and dispositions to teach to solidify their role as teachers [5].

On the other hand, recent research has also highlighted the relevant role of emotions in configuring teacher identity [6]. The emotional profile that teachers experience about their identity is complex and not unidirectional, meaning that PSTs can face teaching challenges associated with "negative" emotions and yet have the ability to reverse these emotions, hence contributing significantly to the development of their teaching identity [7].

2. Aims and Research Questions

This research aims to explore the complex interplay between teacher identity construction, inquiry orientation, and emotional experiences in Physics and Chemistry PSTs during their initial teacher education. Specifically, we examine how these three factors interact and influence each other during the development of the professional teaching identity, addressing the following research question:
[**RQ1**] What are the PSTs' perceptions about inquiry, emotions and identity?
[**RQ2**] What patterns emerge from integrating identity perception, inquiry orientation, and emotional experiences in PSTs?

3. Methodology

This research presents a case study developed with eight Physics and Chemistry PSTs of the Secondary Teaching Master Degree (MEd) at the University of Málaga during the academic year 2020/2021. They all held a bachelor's or master's degree in either Science or Engineering, a prerequisite to enrolling in the MEd, which is compulsory to become a Secondary Education Teacher. All participants had different teaching and research experience levels, although not in a professional way.
Data were collected in agreement with the Ethics Committee of the University of Málaga (CEUMA) (ref. no. 139-2023-H) during the completion of the MEd, where PSTs received specific instruction about inquiry-based science education, teacher identity and emotions through a training program outlined to promote the professional development associated with these aspects [8],[9].
We employed an integrated multidimensional analysis approach to examine the relationships between teacher identity, emotional experiences, and inquiry orientation. This approach allows for systematically comparing and integrating data from three distinct quantitative instruments, identifying patterns and relationships across these factors of teacher development (Figure 1).

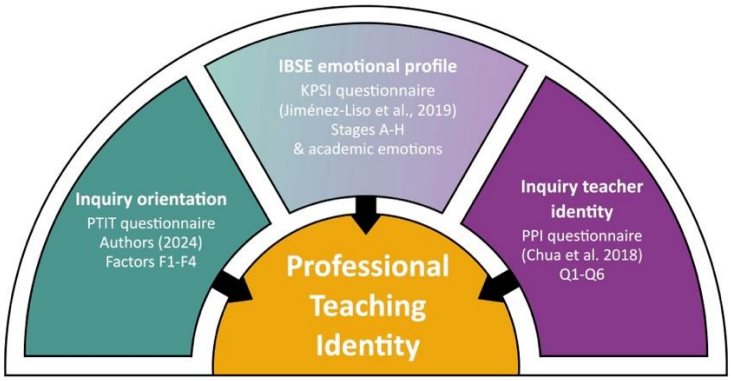


Fig. 1. Integrated multidimensional analysis framework

To deepen the perception of inquiry, we applied the validated PSTs IBSE perception (PTIT) Likert-type questionnaire (1: totally disagree to 4: totally agree) [10], which provides an idea of the PSTs' disposition towards inquiry-based science education (IBSE). To do so, we calculated the participants' scores for each of the four factors composing the questionnaire (**F1**, IBSE teaching practice; **F2**, IBSE students' applicability; **F3**, IBSE difficulties related to personal aspects; and **F4**, IBSE difficulties related to external aspects). Regarding the emotional profile that emerged in the teaching role, we adapted the instrument described by Jiménez-Liso et al. [11], including the stages of the design of inquiry activities (**A**, focussing; **B**, context; **C**: development; **D**: curriculum; **E**: management; **F**: assessment; **G**: communication, and **H**: transfer), combining the multiple selection of achievement (**TRU**, trust; **SAT**, satisfaction; **SHA**, shame, and **DIS**, dissatisfaction) and epistemic emotions (**INT**, interest; **CON**, concentration; **BOR**, boredom; **REJ**, rejection and **INS**, insecurity).
Finally, to explore identity perception we applied an adaptation of the validated Professional Practice and Inquiry (PPI) questionnaire created by Chua et al. [12], selecting six Likert-type questions (1: strongly disagree, 5: strongly agree) aimed to detangle what it means to be an inquiring teacher professional (**Q1-Q6**), showing the PSTs capability of being effective inquirers regarding their teaching practices and identity development.

4. Findings

Figure 2 shows the comparison of the inquiry, emotions and identity profile by participant, revealing some interesting variations and commonalities. When analysing the participants' orientation toward inquiry [**RQ1**], some patterns across the group arose.

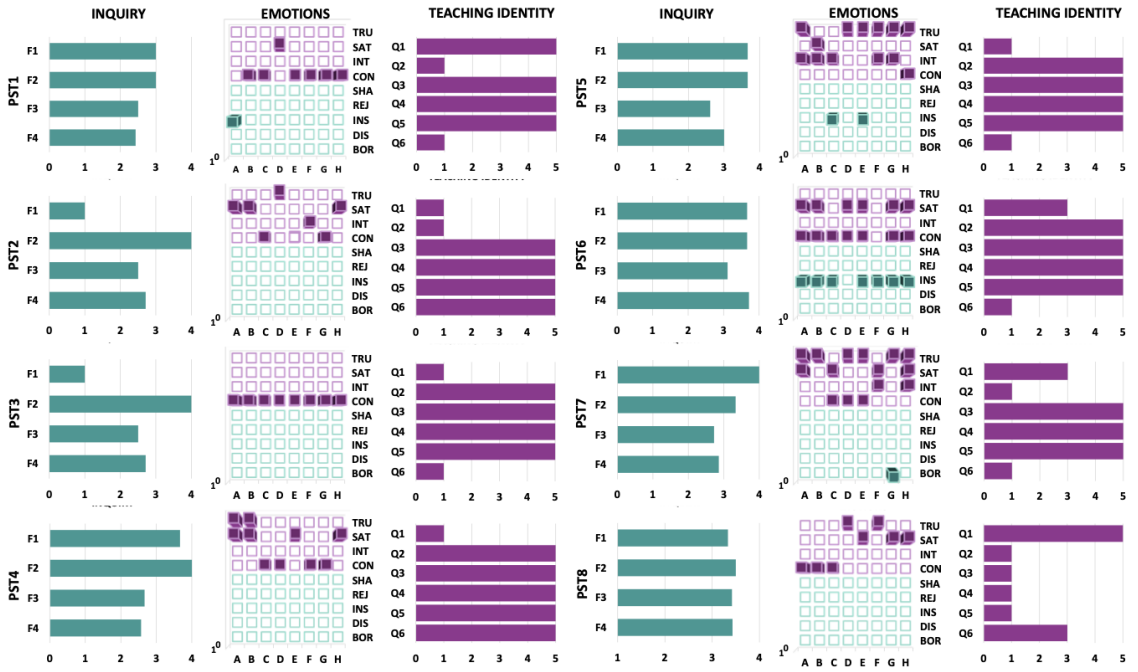


Fig. 2. Comparison of the identity, inquiry and emotional profile by participant

Factor **F2** emerged as a decisive dimension across participants, suggesting they recognise the motivational value of inquiry-based approaches for students and indicating a predominantly student-centred perspective. The contrast between internal difficulties (**F3**) and external difficulties (**F4**) provides mixed insight into perceived barriers, with scores being relatively similar in both dimensions. The data also revealed that PST6 and PST8 demonstrated exceptionally balanced scores across all inquiry factors, indicating a solid overall orientation toward inquiry-based teaching practices. In contrast, PST2 showed a disparity between factors, with particularly low scores in **F1**, but high in **F2**, suggesting strong recognition of IBSE value for students despite challenges in implementation.

The participants' emotional experiences during IBSE activities [**RQ1**] revealed a predominance of positive emotions, with concentration emerging as the most frequently experienced emotion. Trust and satisfaction also appeared consistently, though with varying patterns among different participants. PST5 and PST7 demonstrated particularly strong positive emotional profiles. While negative emotions (insecurity, dissatisfaction, boredom) were less frequent, some participants, such as PST6, exhibited a more diverse emotional range, stressing the complex nature of emotional development during teacher preparation.

Considering teaching identity [**RQ1**], most participants (except PST8) demonstrated stronger connections to aspects linked to questions **Q3**, **Q4**, and **Q5** related to ways to improve teaching practice. However, participants showed lower scores in establishing past-present connections (**Q6)** likely reflecting their limited teaching experience. The variation in **Q1** ("having a question in mind") and **Q2** ("thinking about classroom experiences to support my stance") also suggests different levels of engagement with evidence-based reflective practice. Particularly interesting were the cases of PST4 and PST8, who exhibited distinctly different identity profiles from their peers. PST4 demonstrated remarkably consistent high scores across all identity dimensions, suggesting a well-developed and balanced teaching identity. In contrast, PST8's profile revealed more moderate scores, indicating a different trajectory in identity development.

One of the most compelling findings emerged from examining relationships between the three dimensions (identity, inquiry and emotions) [**RQ2**]. Some participants with high teaching identity scores (particularly in Q3-Q5) showed varying inquiry orientation scores, suggesting these aspects of teacher development might not be as directly related as previously assumed. The emotional dimension adds another layer of complexity, with positive emotions (*trust, satisfaction, confidence*) appearing across different profiles regardless of identity or inquiry scores.
A particularly interesting case was PST8, whose profile showed a distinctive pattern. Despite lower scores in identity dimensions (especially Q3-Q5), this participant demonstrated consistently moderate-to-high inquiry scores across all factors, while maintaining positive emotions (concentration, satisfaction), challenging simple correlations and suggesting that balanced inquiry perceptions can coexist with different identity profiles.
These findings lead us to suggest three main development patterns (table 1): i) confidence-led development, exemplified by PST4-PST6, showing particularly high reflection scores (**Q3-Q5**), strong F1 and F2 scores, and predominantly positive emotions across phases, though notably PST6 also expressed insecurity; ii) a growth-oriented pattern, exhibited by PST2, PST3 and PST7, with strong improvement-focused reflection (**Q3, Q5**) but more variations in **Q1, Q6** and **F1** scores, accompanied by generally positive emotional responses; and iii) a challenge-aware development, represented by PST1 and PST8.

Table 1. Suggested patterns correlating identity, inquiry and emotions for each participant

Pattern type	PST	Identity*						Inquiry**				Most frequent emotions
		Q1	Q2	Q3	Q4	Q5	Q6	F1	F2	F3	F4	
Confidence-led	4	1	5	5	5	5	5	3.7	4.0	2.7	2.6	CON, SAT
	5	1	5	5	5	5	1	3.7	3.7	2.6	2.1	INT, TRU
	6	3	5	5	5	5	1	3.7	3.7	3.1	3.7	CON, SAT, INS
Growth-oriented	2	1	1	5	5	5	5	1.0	4.0	2.5	2.7	CON, SAT
	3	1	5	5	5	5	1	3.5	4.0	2.7	2.6	CON
	7	3	1	5	5	5	1	3.5	3.3	2.7	2.9	SAT, TRU
Challenge-aware	1	5	1	5	5	5	1	3.0	3.0	2.5	2.4	CON
	8	5	1	1	1	1	3	3.3	3.5	3.4	3.4	CON, SAT

* Scores ** Factor mean value

5. Conclusions and Educational Implications

This research shows how PSTs perceived the development of their teacher identity, their readiness to inquiry and their emotional profile experienced during the MEd. Performed as a case study, the varied profiles observed in this study highlight the importance of personalized approaches to teacher education that can accommodate and support different developmental trajectories while maintaining high standards for professional growth.
With the caution due to the reduced number of participants, the emergence of three distinct developmental patterns (confidence-led, growth-oriented, and challenge-aware) suggests that becoming a science teacher is not a uniform process but rather a highly individualized journey where multiple pathways can lead to successful professional development.
Despite the limitations of our small sample size, these insights provide valuable direction for future research and practice in science teacher education, particularly in understanding how to better support PSTs in developing their teaching identity through inquiry-based approaches while attending to their emotional well-being. Integrating these three dimensions - identity, inquiry, and emotions - is fundamental in shaping effective science teachers, suggesting that teacher education programs should explicitly address and support all three aspects of their curriculum and practice.

6. Acknowledgement

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Innovating Entrepreneurship Education through Lived Practice: A Self-Study of Professional Practice Using the 4Ps of Innovation

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Abstract

*Entrepreneurship education in higher education increasingly emphasises innovation, authenticity and experiential learning, yet limited research has examined how educators' own entrepreneurial practice informs innovation pedagogy. This paper presents an innovation-focused self-study of professional practice that explores how the author's dual role as a micro-entrepreneur and business educator enriched student learning and supported ongoing business development through the application of the **4Ps of Innovation framework** [3]. Drawing on reflective self-inquiry, professional teaching artefacts and curriculum design decisions, the study examines how product, process, position and paradigm innovation were modelled through lived micro-enterprise practice and embedded within entrepreneurship teaching. The findings suggest that using the 4Ps as a reflexive bridge between theory and practice enabled students to engage with innovation as an accessible, iterative and sustainable activity, while simultaneously informing continuous improvement within the micro-business. While context-specific, the study offers analytically transferable insights and a practice-informed framework that other entrepreneurship educators and practitioner-researchers can adapt.*

Keywords: *self-study of professional practice; innovation education; 4Ps of innovation; micro-enterprise; entrepreneurship education*

1. Introduction

Innovation is positioned as a core pillar of entrepreneurship education within UK higher education, aligned with sector priorities around employability, enterprise capability and real-world relevance [1],[5]. Yet innovation is frequently presented in ways that privilege technological disruption, scalability and high-growth start-up cultures. Such representations risk narrowing students' conceptual understanding and obscuring the incremental and multidimensional nature of innovation that characterises the majority of UK enterprises, particularly micro-businesses [4].

The 4Ps of Innovation framework conceptualises innovation across four domains:

- **Product innovation** – changes in goods or services
- **Process innovation** – changes in creation and delivery methods
- **Position innovation** – changes in market context or framing
- **Paradigm innovation** – changes in underlying mental models or business logic [3]

This framework provides a broader lens through which innovation can be understood beyond technological novelty. However, while widely cited in innovation management literature, its pedagogical operationalisation within entrepreneurship education remains underexplored. Many entrepreneurship educators simultaneously engage in entrepreneurial activity. The potential of this dual professional identity to model multidimensional innovation for students has received limited scholarly attention. This paper addresses that gap by examining how the author's micro-enterprise practice was analysed and enacted through the 4Ps framework and embedded within entrepreneurship teaching through a self-study of professional practice.

2. Micro-enterprise, and the Multidimensionality of Innovation

Micro-enterprises, defined as businesses employing fewer than ten individuals, constitute the dominant form of enterprise within the UK economy [4]. Operating under constrained resources, such businesses rarely engage in radical innovation. Instead, innovation emerges incrementally and pragmatically across multiple dimensions.

Within micro-enterprise contexts:

- **Product innovation** may involve adaptation, bundling, or refinement rather than invention.
- **Process innovation** often centres on efficiency, customer interaction models or digital integration.
- **Position innovation** may involve reframing services to reach new markets or alter perceived value.
- **Paradigm innovation** may require rethinking the fundamental assumptions underpinning value creation.

Entrepreneurship education has historically privileged product-focused narratives of innovation. This emphasis risks reinforcing a narrow understanding of entrepreneurial success. The 4Ps framework challenges this by foregrounding innovation as systemic and interconnected, aligning more closely with micro-enterprise realities and offering a more inclusive and attainable conception of innovation for students [3]. Bessant and Tidd [3] argue that innovation should be understood as a multidimensional process extending beyond product development to include changes in processes, positioning and organisational paradigms. This broader conceptualisation is particularly relevant within entrepreneurship education, where students may otherwise develop narrow understandings of innovation associated primarily with technological invention or high-growth business models. While alternative innovation frameworks such as Design Thinking [8] and Lean Startup approaches [9] emphasise iterative problem-solving, customer feedback and rapid experimentation, these models often focus primarily on product development and venture creation processes. In contrast, the 4Ps of Innovation framework offers a broader conceptualisation of innovation by recognising that innovation can occur simultaneously across products, processes, positioning and organisational paradigms. This multidimensional perspective is particularly valuable within entrepreneurship education because it enables students to identify innovation opportunities beyond technological invention or high-growth start-up cultures. The framework therefore aligns closely with experiential and reflective pedagogies by helping students analyse innovation within authentic, resource-constrained and practice-based contexts.

3. Methodological Framework: Self-Study of Professional Practice

This study adopts a self-study of professional practice methodology, positioning the educator's entrepreneurial and pedagogical activities as the primary site of inquiry. Self-study approaches are well established in teacher education and the scholarship of teaching and learning, where they facilitate systematic interrogation of professional knowledge-in-practice [6], [7]. Entrepreneurial decision-making was not treated as an anecdotal illustration but as analytically interrogated data. Innovation decisions within the micro-enterprise were retrospectively and contemporaneously mapped against the 4Ps framework. These reflections were then traced into curriculum design, assessment construction and classroom dialogue. The purpose was not statistical generalisability but analytical transferability, generating conceptual insights that may inform similar educator-practitioners operating within entrepreneurship education contexts.

4. Conceptual Framework: the 4Ps of Innovation as Pedagogical and Reflexive Framework

The conceptual framework integrates dual professional identity with the 4Ps of Innovation as both:

1. **Analytical Lens** – to examine innovation within the micro-enterprise
2. **Pedagogical Scaffold** – to structure innovation teaching
3. **Reflexive Tool** – to interrogate underlying entrepreneurial assumptions

Within the micro-enterprise, innovation was mapped systematically:

Product Innovation
Refinement of service offerings, bundling strategies and experience design were analysed not as routine adjustments but as deliberate innovation activity.
Process Innovation
Operational systems, client onboarding, digital tools and workflow redesign were examined as forms of value-creating innovation rather than administrative necessity.
Position Innovation

Market reframing and shifts in target audience communication illustrated how repositioning altered perceived value without altering core offerings.

Paradigm Innovation

Most significantly, underlying assumptions concerning value, growth, and entrepreneurial success were critically interrogated. This level of innovation challenged taken-for-granted entrepreneurial narratives and reshaped both business strategy and teaching philosophy.

Embedding these dimensions into curriculum design allowed innovation to be presented as layered and systemic rather than singular or product driven.

5. Methodology: Innovation-focused Self-study Process

The research process mirrored innovation itself: iterative, reflective and recursive.

Professional artefacts analysed included:

- Module learning outcomes
- Assessment briefs
- Teaching slides and case materials
- Student innovation analyses

These artefacts were examined to trace how the 4Ps framework increasingly structured:

- Classroom questioning
- Assessment rubrics
- Student business analysis tasks
- Feedback language

Thematic analysis identified recurring shifts:

- Movement from product-centric examples toward multidimensional innovation mapping
- Increasing emphasis on paradigm questioning
- Greater student ability to identify interconnections across innovation types

Literature on experiential learning and innovation management provided a critical interpretive frame [3],[10]. Reflexivity formed an important component of the research process, particularly given the author's dual role as educator and micro-entrepreneur. Ongoing reflective journaling and iterative revisiting of teaching artefacts enabled assumptions, biases and professional positioning to be critically interrogated throughout the study. Rather than attempting to eliminate subjectivity, the study acknowledged practitioner perspective as a valuable source of insight, consistent with established principles of self-study research [6].

6. Findings: The Pedagogical Power of the 4Ps

The findings reveal that the 4Ps of Innovation framework functioned as more than a conceptual model for analysing business activity. Within this study, the framework became a pedagogical scaffold that enabled students to engage with innovation as a multidimensional, iterative and accessible process grounded in authentic entrepreneurial practice. Three interrelated pedagogical insights emerged from the analysis.

6.1 Making Innovation Accessible through Micro-enterprise Practice

Framing innovation through lived micro-enterprise practice made innovation more accessible and less intimidating for students. Initially, many students associated innovation primarily with technological disruption, invention or large-scale entrepreneurial ventures. However, engaging with authentic examples drawn from a functioning micro-enterprise enabled students to reconceptualise innovation as incremental, contextual and achievable.

At the level of **product innovation**, students began to recognise that innovation does not necessarily involve creating entirely new products or services. Instead, innovation was understood through adaptation, refinement and recombination. Incremental changes to service offerings, customer experience and delivery methods demonstrated how innovation could emerge through continuous improvement rather than radical invention. This reduced student anxiety surrounding innovation and broadened perceptions of what entrepreneurial creativity might involve.

Similarly, **process innovation** helped students recognise forms of innovation that are frequently overlooked within entrepreneurship education. Operational systems, workflow redesign, client communication practices and digital integration were initially perceived as administrative or routine activities rather than innovation. Mapping these practices explicitly against the 4Ps framework made visible how value is created and delivered within resource-constrained contexts. Students subsequently demonstrated greater awareness of the strategic importance of operational innovation within small businesses.

The study also highlighted the pedagogical value of **position innovation**. Students demonstrated increasing sophistication when analysing how identical services could be repositioned for different audiences, contexts or value propositions without fundamentally altering the core offering itself. This challenged assumptions that innovation must involve changing the product or operational structure and instead highlighted the importance of communication, perception and market framing.

Together, these dimensions repositioned innovation as an ongoing and multidimensional activity embedded within everyday entrepreneurial practice rather than as an exceptional or distant achievement. This broader conceptualisation appeared particularly valuable for students who did not initially identify with high-growth or technology-driven entrepreneurial narratives.

6.2 Bridging Innovation Theory and Practice through the 4Ps Framework

The 4Ps of Innovation framework provided a shared conceptual language that effectively bridged academic theory and lived entrepreneurial experience. Students engaged more deeply with innovation concepts when they could observe how product, process, position and paradigm innovation operated simultaneously within a real micro-enterprise context.

The framework supported movement beyond surface-level understandings of innovation by encouraging students to identify interconnected forms of change within a single business example. Rather than viewing innovation as isolated acts of product development, students increasingly recognised the systemic relationships between operational processes, market positioning and underlying business assumptions. This multidimensional perspective aligned more closely with the realities of contemporary micro-enterprise practice.

The consistent application of the 4Ps framework across teaching activities, case discussions and assessment tasks also provided coherence within the curriculum. Students became more confident in applying innovation theory critically to their own entrepreneurial ideas and analyses. The framework therefore functioned not only as a descriptive model but as a cognitive scaffold that structured analytical thinking and supported deeper engagement with entrepreneurship concepts.

Importantly, the framework also enabled innovation to be discussed in more inclusive and realistic terms. By foregrounding incremental and context-specific innovation rather than exclusively disruptive or technological models, the teaching approach validated diverse entrepreneurial pathways and experiences. This appeared to strengthen students' confidence in recognising innovation opportunities within familiar and constrained contexts.

6.3 Paradigm Innovation and Reciprocal Reflection

The most transformative pedagogical insight emerged at the level of **paradigm innovation**, where both students and educator engaged in deeper questioning of underlying entrepreneurial assumptions. Students began critically examining dominant narratives surrounding business growth, success and innovation, exploring alternative entrepreneurial logics and definitions of success aligned with sustainability, lifestyle entrepreneurship, wellbeing and community impact. Paradigm innovation therefore extended beyond business operations into the formation of entrepreneurial identity and values.

At the same time, the process of teaching innovation prompted ongoing reflection within the micro-enterprise itself. Preparing teaching materials, articulating innovation concepts and facilitating classroom discussion encouraged critical interrogation of existing business assumptions and practices. Teaching became a reflexive space in which entrepreneurial decisions were reconsidered and opportunities for further innovation identified.

This reciprocal relationship between teaching and entrepreneurial practice became one of the most significant findings of the study. Pedagogical reflection informed business development, while lived entrepreneurial experience continually reshaped curriculum design and classroom dialogue. The 4Ps framework therefore functioned simultaneously as an analytical lens, a pedagogical scaffold and a professional reflexive tool.

The findings suggest that innovation pedagogy can extend beyond supporting student learning to become a mechanism for ongoing professional learning and business development for educator-practitioners themselves. In this way, innovation emerged not as a linear outcome but as a cyclical and reflective process operating across both educational and entrepreneurial domains.

7. Contribution and Usefulness of the Study

This study contributes to entrepreneurship education literature by extending understandings of how innovation pedagogy can be authentically enacted through educators' own entrepreneurial practice. While entrepreneurship education research frequently emphasises student learning experiences, less attention has been given to how educators' dual professional identities shape the teaching of innovation. This study therefore foregrounds the educator not simply as facilitator of entrepreneurial learning, but as an active site of innovation practice and reflective inquiry.

A key contribution of the study lies in demonstrating how the 4Ps of Innovation framework can operate simultaneously as an analytical lens, pedagogical scaffold and reflexive professional tool. Rather than presenting innovation as primarily technological or product-driven, the study illustrates how product, process, position and paradigm innovation can be embedded within everyday micro-enterprise activity and translated into authentic and practice-oriented entrepreneurship teaching. In doing so, the paper extends existing applications of the 4Ps framework by illustrating its pedagogical usefulness within higher education contexts and its relevance to small-scale, resource-constrained entrepreneurial environments.

The findings also contribute to wider debates concerning inclusivity within entrepreneurship education. By repositioning innovation as incremental, multidimensional and contextually situated, the study challenges dominant high-growth and disruption-oriented narratives that can unintentionally alienate students who do not identify with traditional entrepreneurial archetypes. The pedagogical approach presented here therefore supports broader and more accessible understandings of entrepreneurial capability and innovation practice.

Methodologically, the study demonstrates the value of self-study of professional practice as an approach for examining innovation pedagogy within higher education. The integration of reflective inquiry, professional artefacts and lived entrepreneurial experience enabled the development of analytically transferable insights into the relationship between teaching, professional identity and innovation. In particular, the study highlights the significance of reciprocal reflection, where teaching informs entrepreneurial development while entrepreneurial practice simultaneously reshapes pedagogy.

While context-specific, the conceptual framework and reflective processes developed through this study may offer a useful model for other entrepreneurship educators and practitioner-researchers seeking to integrate innovation theory, authentic practice and reflexive teaching within their own educational contexts.

8. Limitations and Ethical Considerations

As a self-study of professional practice, the findings are context-specific and are not intended to be statistically generalisable. Instead, the study seeks to provide analytically transferable insights that may resonate with and inform the practice of other entrepreneurship educators operating within similar contexts. The interpretations presented are shaped by the author's dual role as educator and micro-entrepreneur, which inevitably introduces elements of subjectivity into the research process. However, within self-study methodology, such positionality is not viewed solely as a limitation but as a valuable source of professional insight and reflexive understanding [6],[7].

The dual-role nature of the study also required ongoing reflexivity to mitigate the potential for uncritical self-representation or confirmation bias. Critical reflection was therefore embedded throughout the research process, particularly during the interpretation of professional experiences and teaching artefacts. Engagement with relevant literature and systematic interrogation of recurring themes supported analytical rigour and helped situate personal reflections within broader educational and entrepreneurship debates.

Ethical considerations were addressed through anonymisation of teaching contexts and a focus on professional learning rather than evaluation of students or colleagues, in line with established ethical guidance for practitioner research [2]. No student data were used directly within the study, and reflective analysis centred primarily on curriculum design, pedagogical practice and professional experience.

A further limitation relates to the scale and specificity of the micro-enterprise context examined. The innovation practices discussed may not fully reflect the realities of larger organisations or different disciplinary settings. Nevertheless, the study's focus on micro-enterprise offers an important contribution to entrepreneurship education, given the prevalence of small and resource-constrained businesses within contemporary economies.

9. Conclusion

This paper has demonstrated how the integration of lived micro-enterprise experience with the 4Ps of Innovation framework can enrich entrepreneurship education by bridging innovation theory and authentic professional practice. Through a self-study of professional practice, the research illustrated how product, process, position and paradigm innovation can be enacted within everyday entrepreneurial activity and translated into meaningful pedagogical experiences for students. The findings suggest that the 4Ps framework offers more than a model for analysing business innovation; it can also function as a pedagogical scaffold and reflexive professional tool that supports deeper engagement with entrepreneurship learning. By reframing innovation as multidimensional, incremental and contextually situated, the study challenges narrow representations of entrepreneurship that privilege technological disruption and high-growth ventures. Instead, innovation is positioned as an accessible and ongoing process embedded within real-world entrepreneurial practice.

A particularly significant insight concerns the role of paradigm innovation and reciprocal reflection. The study demonstrated how teaching innovation can simultaneously reshape entrepreneurial practice, while lived entrepreneurial experience continually informs curriculum design and pedagogical decision-making. In this way, dual professional identity emerges not simply as background experience, but as a valuable source of innovation knowledge, reflexive inquiry and authentic learning.

While context-specific, the study contributes analytically transferable insights into how entrepreneurship educators may integrate innovation theory, professional practice and reflective pedagogy to create more inclusive, grounded and practice-oriented approaches to entrepreneurship education.

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Prospective Teachers' Knowledge of Multiplication

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Abstract

According to the Norwegian curriculum ([1]), students are expected to learn the basics of multiplication in third grade. It is therefore important that prospective primary school teachers possess solid knowledge of how to teach multiplication ([2]). While there is a substantial body of research on prospective teachers' understanding of multi-digit multiplication algorithms ([3]), comparatively little attention has been given to how prospective teachers solve multiplication problems that do not require the use of standard algorithms. Inspired by the study of Fischbein et al. (1985) ([4]), which investigated how Italian students solved word problems involving multiplication and division, we conducted a study examining how 46 prospective primary school teachers, in their first semester of teacher education, solved eight arithmetic problems. Four of these problems focused on multiplication and proportionality. The prospective teachers' solutions to these four problems constitute the data material for the present study. The prospective teachers' solutions were analyzed using a thematic qualitative analysis approach ([5]). Since the tasks solved by the prospective teachers fall between what the literature describes as single-digit arithmetic and multi-digit arithmetic ([6]), we developed an analytical framework tailored to this intermediate level. This framework was inspired by Hickendorff et al.'s (2019) ([6]) classification system for multi-digit multiplication strategies, as well as by Cramer and Post's (1993) ([7]) categorization of solution strategies for proportionality tasks. The results indicate that prospective teachers predominantly rely on procedural knowledge when solving problems related to multiplication and proportionality. This suggests a need for changes in teacher education, with greater emphasis on fostering prospective teachers' conceptual understanding of these topics.

Keywords: *Prospective teachers, multiplication, proportionality, solution strategies, procedural knowledge*

1. Introduction

The four basic arithmetic operations are fundamental to further learning in mathematics. It is therefore crucial that students acquire solid knowledge and skills in these operations during primary school. It is difficult to argue that one of the four operations is more important than the others; however, multiplication is sometimes described as the core of basic arithmetic instruction, as an operation, and it is a key component of several other mathematical topics, such as division, fractions, and proportionality ([8]). In the Norwegian school system, multiplication is introduced in Grade 3 (ages 7–8) ([1]). At this grade level, four out of eleven competence aims relate to multiplication. In Grade 4 (ages 8–9), three out of ten competence aims include content relevant to multiplication, such as exploring and explaining relationships between the four arithmetic operations. In addition, three of the competence aims focus on division, which is the inverse operation of multiplication. This highlights multiplication as a central topic for students in Grades 1–4 in the Norwegian school system.

Teachers' competence is crucial in the challenging and complex process of teaching mathematics. More specifically, specialized content knowledge in mathematics is essential for teachers to teach mathematics effectively ([9]). Teachers who have developed advanced levels of specialized content knowledge are better equipped to understand students' thinking and to interpret the solutions students produce ([2]). For this reason, teacher education programs aim to educate teachers who develop and acquire deep specialized content knowledge. Furthermore, although this may seem self-evident, it is worth emphasizing that teachers who teach multiplication should themselves have a solid understanding of the operation of multiplication ([10]).

It has long been recognized that students' arithmetic is characterized by strategic variation, meaning that students use a variety of different strategies to solve arithmetic problems ([11]; [6]). This variation includes both interindividual variation, which refers to different individuals relying on different strategies to solve a given arithmetic task, and intraindividual variation, which refers to a single individual using

different strategies to solve different tasks, or even the same task at different points in time and/or in different contexts ([4]; [12]).
Several studies have examined how prospective teachers apply multi-digit multiplication algorithms ([3]) and have concluded that they experience difficulties in understanding these algorithms. However, there is limited research on how prospective teachers solve multiplication problems that do not require the use of algorithms. Therefore, in the present study, we investigate how 46 prospective teachers enrolled in the primary teacher education program (Grades 1–7) solve multiplication tasks that do not require the use of a multiplication algorithm.
The data material in this study is based on eight arithmetic tasks solved by 46 prospective teachers enrolled in the primary teacher education program (Grades 1–7). The first four tasks required the use of addition and subtraction and are not included in the present study. The remaining four tasks address multiplication and proportionality, and it is the students' solutions to these tasks that are analyzed in this study. The tasks are inspired by the study by Park and Nunes (2001) ([13]) and are presented in Table 1.

2. Theory

In this section, we highlight different situations and definitions of multiplication that are considered relevant for the present study. Greer (1992) ([14]) describes ten different situations for multiplication. Two of these are identified in this study: repeated addition with equal groups and multiplicative change of quantities (proportionality). An example of repeated addition with equal groups is: *"3 children each have 4 oranges. How many oranges do they have altogether?"* In contrast, the task *"A piece of elastic can be stretched to 3.3 times its original length. What is the length of a piece that is 4.2 meters long when fully stretched?"* exemplifies multiplicative change of quantities ([14]).
Lampert (1986) ([15]), on the other hand, describes multiplication as an operation involving two factors, $a \cdot b$, where the factor a represents the number of groups (the multiplier) and the factor b represents the number of objects in each group (the multiplicand). The product ($a \cdot b$) indicates the total number of objects across all groups. This relationship can be expressed as $a \cdot b = p$ ([16]). This definition is consistent with Fischbein et al. (1985) ([4]), who describe multiplication as $operator \cdot operand$, where the operator represents the number of groups and the operand represents the number of objects in each group.
When considering the commutative property of multiplication ($a \cdot b = b \cdot a$), the factors take on different roles (cf. [15]). According to Beckmann and Izsák (2015) ([17]), the fact that the multiplier and multiplicand assume different roles results in two different perspectives on proportional relationships: the *multiple-batches perspective*, where the multiplier varies and the multiplicand remains constant, and the *variable-parts perspective*, where the multiplicand varies and the multiplier remains constant.
Although multiplication can be defined as $multiplier \cdot multiplicand = product$ ([15]; [16]), research shows that students perform multiplication in multiple ways ([6]; [11]). Sherin and Fuson (2005) ([11]) describe the development of different solution strategies for single-digit multiplication, including counting with drawings, fingers, and rhythm; additive calculation through repeated addition and grouping; pattern-based calculation; recalled products; and multiplicative reasoning. In contrast, Hickendorff et al. (2019) ([6]) identify several solution strategies for multi-digit multiplication, such as sequential strategies, decomposition, variation strategies, column-based methods, and standard algorithms for multiplication.
Our theoretical framework is based on the two situations for multiplication identified by Greer (1992) ([14]) that are present in this study: repeated addition with equal groups and multiplicative change of quantities (proportionality). In the study by Fischbein et al. (1985) ([4]), repeated addition is presented as a primitive model of multiplication. Most of the students in the study by Park and Nunes (2001) ([13]) initially used additive strategies when learning multiplication. However, the goal is for students to adopt multiplicative solution strategies, which represent a more conceptual understanding of multiplication and are based on a correspondence scheme ([13]).
Proportionality refers to a multiplicative relationship between quantities represented in a situation and can be expressed algebraically as $y = m \cdot x$ ([7]). Cramer and Post (1993) ([7]) describe four different solution strategies for proportionality problems, two of which are included in our framework: the *unit-rate strategy* and the *factor-of-change strategy*. The unit-rate strategy involves determining the value of one unit and then scaling it up to find the required quantity. The factor-of-change strategy involves solving the problem through multiplication; for example: *"It takes 20 minutes to drive four miles. Since Mark is driving three times as far, it should take three times as long. Therefore, the answer is 20 minutes times three, or 60 minutes"* ([7]).

Mathematical knowledge can be divided into two types: *procedural* and *conceptual knowledge* ([18]). Procedural knowledge of multiplication involves understanding multiplication as repeated addition, for example interpreting $4 \cdot 5$ as taking the number 5 four times (5 + 5 + 5 + 5) ([19]). Conceptual knowledge of multiplication, by contrast, involves: (1) understanding the concepts and mathematical content associated with multiplication; (2) the ability to solve multiplication problems using a variety of strategies and representations; and (3) the ability to retrieve basic multiplication facts directly from memory ([20]). One approach to teaching multiplication that supports the development of conceptual understanding includes the use of manipulatives, symbolic representations of these manipulatives, group or pair discussions, and the use of everyday contexts ([21]). Manipulatives can help students develop an understanding of mathematical concepts and operations, and when combined with symbolic representations, they can further strengthen mathematical understanding ([22]). Working in groups or pairs and engaging in discussion allows students to articulate their mathematical thinking to peers, which can help consolidate their understanding ([23]). Using everyday context enables students to connect mathematics to their own experiences ([22]).

The study by Park and Nunes (2001) ([13]) shows that the choice of strategy distinguishes between the development of procedural and conceptual understanding of multiplication. Repeated addition was used to foster procedural understanding, whereas conceptual understanding of multiplication emphasized the relationship between the number of groups and the number of objects in each group. One finding of their study was that students who received instruction emphasizing conceptual understanding developed a deeper understanding of multiplication. This suggests that repeated addition may be useful in introducing multiplication as a calculation procedure, but not as a foundation for understanding the concept of multiplication itself.

Özel et al. (2022) ([10]) also highlights the importance of being aware of the distinction between procedural and conceptual knowledge. They found that most of the prospective teachers in their study correctly evaluated students' solutions to multiplication problems. However, the evaluations were primarily based on the prospective teachers' procedural knowledge rather than their conceptual understanding of multiplication.

Repeated addition can be viewed as a primitive model of multiplication (cf. [4]). Based on Greer's (1992) ([14]) multiplication situations, Bao (2023) ([24]) investigated students in Grades 3–6 and their solutions to four multiplication tasks. Bao found that, for tasks involving equal groups, many students used repeated addition as a solution strategy, suggesting that such tasks may not sufficiently support the development of multiplicative thinking.

Proportionality is a fundamental skill in mathematics education and serves as a bridge between basic arithmetic and more advanced mathematical concepts ([27]). It encompasses a range of mathematical ideas, including fraction equivalence, division, place value, percentages, and unit conversions ([28]). Developing a strong understanding of proportionality is therefore considered essential for students' overall mathematical learning ([27]). Despite its importance, numerous studies indicate that students often lack a sound understanding of proportionality. Avcu and Avcu (2010) ([28]) found that most sixth-grade students in their study used the cross-product algorithm to solve rate and proportion problems. However, this strategy lacks a meaningful connection to the context of the tasks, and there is no inherent logical reason for students to select this method ([7]).

In the study conducted by Torma and Kosztolányi (2025) ([30]), in which seventh-grade students solved proportion problems, more than 90% of the students answered the problems correctly on both the pre-test and post-test. Most students used the unit-rate strategy. A comparison of strategy used between the pre-test and post-test revealed no significant change in students' approach to solving proportionality problems.

Modestou and Gagatsis (2009) ([31]) examined how students in primary and secondary school solved proportional and non-proportional tasks. One of their findings was that primary school students primarily used the unit-rate strategy, whereas secondary school students predominantly used cross-multiplication. This result suggests that secondary school students relied on cross-multiplication as a procedural strategy without a corresponding conceptual understanding of proportionality.

3. Methodology

In this study, 46 prospective teachers enrolled in the primary teacher education program (Grades 1–7), during their first semester of teacher education, solved a set of tasks that included four multiplication problems. We analyzed the solutions to the multiplication tasks in order to identify the strategies used by the prospective teachers. The strategies were identified using a qualitative thematic analysis, as described by Braun and Clarke (2013) ([5]). The first step of the analysis involved reviewing the students'

responses to the four multiplication tasks and initially categorizing them according to whether the tasks had been answered or left unanswered. The responses were then further classified into correct and incorrect solutions. The vast majority of the students answered all tasks; one student did not respond to Task 7, and another student did not respond to Task 8. In the next step, the solutions were examined and categorized according to the solution strategies employed. This process resulted in the following categories: proportionality, additive, unit-rate (the "way through 1"), multiplicative, other, and incorrect answers ([11]; [6]; [4]), see Table 2.
The four tasks with a multiplicative structure, which constitute the data material of the study, are presented in Table 1.

Table 1. The four tasks included in the study.

Task	Task description	Mathematical content
5	In a forest, there are 4 birdhouses. There are 4 birds living in each birdhouse. How many birds live in the birdhouses?	Multiplication The multiplier and the multiplicand are known
6	Two gingerbread cookies cost 8 kroner. You buy 4 gingerbread cookies. How much do you have to pay?	Proportionality The mulitple-batchs perspective
7	Two caterpillars eat 5 leaves per day. How many leaves are needed to feed 12 caterpillars for one day?	Proportionality The mulitple-batchs perspective
8	There are 6 pieces in a pack of chewing gum. How many pieces are there in 3 packs of chewing gum?	Multiplication The multiplier and the multiplicand are known

4. Analysis and Results

It has long been recognized that students' arithmetic is characterized by strategic variation, meaning that students use a range of different strategies to solve arithmetic problems ([4]; [12]). However, there are no corresponding studies focusing on prospective teachers. Therefore, in this study, we investigate how prospective teachers solve multiplication tasks that do not require the use of the standard algorithm, but that demand more advanced strategies than those typically used for single-digit multiplication (cf. [11]).
The tasks solved by the students in our study fall between what the literature refers to as single-digit arithmetic and multi-digit arithmetic ([6]). Consequently, we developed our own analytical tool, inspired by the classification system proposed by Hickendorff et al. (2019) ([6]) for multi-digit multiplication and by the solution strategies for proportionality tasks described by Cramer and Post (1993) ([7]).
The analysis in this study is a descriptive analysis ([32]), in which the researcher examines individual occurrences without the need for multiple events or situations. In our case, the students' solutions to the four multiplication tasks constitute the units of analysis. We reviewed the students' solutions and searched for patterns in the data in order to generate categories ([32]). The categories identified through this process were: multiplicative, additive, proportionality, unit-rate ("the way through 1"), other, and a category for incorrect answers.

Table 2. Description of the categories used in the analysis.

Category	Content
Multiplicative strategy	In this category, the students arrived at the answer by multiplying the numbers, that is, they used multiplicative reasoning. We did not distinguish between the two cases 3 × 6 = 18 and 6 × 3 = 18 (example from Task 8), nor between the multiple-batches perspective and the variable-parts perspective as described by Beckmann et al. (2015) ([17]).
Additive strategy	In this category, the students add the multiplicand the number of times indicated by the multiplier; that is, they write 4 + 4 + 4 + 4 = 16 instead of 4 × 4 = 16 (example from Task 5).
The factor of change strategy	Here, the students solved the tasks by viewing the situation as two quantities increasing simultaneously; for example, in Task 6, that when the number of gingerbread cookies is doubled, the price is also doubled.
The unit-rate strategy	This is illustrated, for example, in Task 7, by first determining how many leaves one caterpillar eats (5 ÷ 2 = 2.5) and then multiplying this by the number of caterpillars (2.5 × 12 = 30).
Other	This category includes alternative solution methods that are not mentioned above, for example solutions based on illustrations (drawings). In this category, we also included responses that did not contain any calculations.

Incorrect answer	We chose to place responses that resulted in incorrect answers in a separate category. This category also includes incomplete responses, for example those in which a calculation was set up but not carried out.

We analyzed the prospective teachers' solutions by identifying which solution fit into the different categories, then counting the number of solutions and calculating the percentage distribution across the categories. The results of the analysis are summarized in Table 3.

Table 3. Percentage distribution across the different categories for each task.

	Multiplicative strategy	Additive strategy	The factor of change strategy	The unit-rate strategy	Other	Incorrect answer
Task 5	84,8	2,2	0	0	8,7	4,4
Task 6	0	19,6	17,4	30,4	13,0	19,6
Task 7	0	4,4	28,9	26,7	4,4	35,6
Task 8	88,9	2,2	0	0	6,7	2,2

As shown in Table 3, a large majority of the prospective teachers solved Task 5 (84,8%) and Task 8 (88,9%) using multiplicative reasoning. Only a small proportion answered these tasks incorrectly: 4,4% for Task 5 and 2,2% for Task 8. In both tasks, 2,2% used additive reasoning. Furthermore, 8,7% used other methods in Task 5, while 6,7% did so in Task 8.
The factor-of-change strategy (proportional reasoning) was used by 17,4% of the students in Task 6 and by 28,9% in Task 7. A larger proportion of incorrect solutions was observed for these tasks, with 19,6% answering Task 6 incorrectly and as many as 35,6% answering Task 7 incorrectly. None of the prospective teachers used multiplicative reasoning in either of these tasks. In Task 6, there was considerable variation in strategy choice: 19,6% used additive reasoning and 15,2% used other methods. For Task 7, 4,4% used additive reasoning and 4,4% used other methods.
In summary, the main findings indicate substantial agreement in strategy choice for Tasks 5 and 8, where 84,8% and 88,9%, respectively, used multiplicative reasoning. In contrast, there is greater variation in strategy use for Tasks 6 and 7. Task 6 is also notable in that it has the highest proportion of additive reasoning (19,6%). When considering the factor-of-change strategy and the unit-rate strategy together as approaches to solving proportionality tasks, we find that 45,7% of the responses to Task 6 and 55,6% of the responses to Task 7 were solved using one of these two strategies. These findings form the basis for the discussion in the following section.

5. Discussion and Didactic Implications

We now discuss our findings. In Task 5, multiplicative reasoning dominates, with 84,8% of the prospective teachers using this approach ([7]). This is not surprising given the numbers in the task and the fact that the multiplier and multiplicand are equal (symmetric) ([26]). In Task 8, multiplicative reasoning is also dominant, with 88,9% of the prospective teachers multiplying the numbers given in the task. However, it should be noted that in the analysis we did not distinguish between the order of the multiplier and multiplicand ([25]); we considered $3 \cdot 6 = 18$ and $6 \cdot 3 = 18$ as equivalent solutions. Had we instead emphasized the context ([23]), represented by packages of chewing gum, 95% of those who used multiplicative reasoning would have applied an order of multiplier and multiplicand that does not correspond to the context. They simply multiplied the factors in the order presented in the problem statement, without recognizing that the factors in the commutative property of multiplication ($a \cdot b = b \cdot a$) take on different roles (cf. [15]). This tendency to multiply the numbers as given in the text indicates that the prospective teachers do not understand the significance of context and therefore demonstrate procedural rather than conceptual knowledge of multiplication ([18]).
An additive solution strategy in multiplication involves solving tasks through repeated addition, reflecting procedural knowledge of multiplication. In Tasks 5 and 8, 2,2% of the prospective teachers used repeated addition, while in Tasks 6 and 7 the corresponding percentages were 19,6% and 4,4%, respectively. This suggests that these prospective teachers rely on a primitive model of multiplication ([4]).
Prospective teachers who rely on a primitive model of multiplication ([4]) are likely to teach multiplication as procedural knowledge, using repeated addition as their primary strategy ([13]). These teachers may

also apply procedural knowledge when evaluating students' solutions to multiplication tasks ([10]). Bao (2023) ([24]) emphasizes that providing students with equal-group multiplication tasks may encourage continued use of repeated addition and does not necessarily promote the development of multiplicative thinking.

In this study, the prospective teachers solved two proportionality tasks, both of which involved the multiple-batches perspective ([17]). The analysis shows that 47,8% used proportional reasoning in Task 6, while 55,6% did so in Task 7. The strategies applied within proportional reasoning were the factor-of-change strategy and the unit-rate strategy.

In Tasks 6 and 7, 30,4% and 26,7% of the prospective teachers, respectively, used the unit-rate strategy, which is the same strategy that Modestou and Gagatsis (2009) ([31]) found to be commonly used by students at the primary school level. Based on the competence aims in LK20 ([1]), it is reasonable to assume that the prospective teachers have been taught other methods; nevertheless, they continue to use the same strategy, a finding consistent with the study by Torma and Kosztolányi (2025) ([30]). This suggests that strategy choice is not grounded in an understanding of proportionality, a pattern also noted by Avcu and Avcu (2010) ([29]) regarding the use of the cross-product algorithm. In such cases, students rely on a learned method without a meaningful reference to the context of the problem (cf. [7]). In our study, this implies that the prospective teachers apply a learned method even when it is not the most efficient.

Proportionality serves as a bridge between arithmetic and more advanced mathematical concepts ([27]), such as fraction equivalence, division, place value, percentage calculations, and unit conversions ([28]). Our analysis shows that 19,6% of responses to Task 6 and 35,6% of responses to Task 7 were incorrect. The most common incorrect answer in Task 7 was that 60 leaves are needed to feed 12 caterpillars; among those who answered incorrectly, 68,8% provided this response. This indicates that the prospective teachers demonstrate limited or insufficient procedural knowledge of proportionality ([18]).

Our findings indicate that the prospective teachers primarily possess procedural knowledge of multiplication and proportionality. This suggests that teacher education must be changed to place greater emphasis on the development of conceptual knowledge in these areas. One approach is to problematize the commutative property of multiplication ($a \cdot b = b \cdot a$) by demonstrating how the factors assume different roles when situated in context (cf. [15]; [17]). In addition, instruction for prospective teachers should foreground concepts and mathematical content in multiplication, promote the use of varied strategies and representations, and support the development of a broader foundation of multiplication facts ([20]).

With regard to proportionality, instruction should likewise foreground conceptual understanding. One possible approach is to use examples that demonstrate that although the unit-rate strategy can lead to correct answers, a strong understanding of proportionality supports the selection of more efficient strategies that preserve relationships. This can be seen as analogous to solving multiplication problems through repeated addition. To foster this understanding, instruction should provide opportunities for prospective teachers to engage deeply with proportional functions and the role of the proportionality constant. In this way, teacher education can support the development of prospective teachers' conceptual knowledge of proportionality.

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The Case Method as a Strategy to Enhance Teaching Effectiveness in University Classrooms

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Abstract

The case method has traditionally been used in business, law and medical education. But it has also become a common and powerful teaching tool in many other academic fields. However, due to limited evidence, the effectiveness of case studies in fulfilling specific learning objectives remains a topic of discussion. This study aims to contribute to the discussion by examining the experiences of 24 faculty members from various disciplines at a private university in southeastern Mexico who collaboratively designed and implemented 12 original teaching cases tailored to their respective fields. Through semi-structured interviews, participant reflections, and analysis of the developed cases, data collected revealed how the case method fostered interdisciplinary collaboration, critical thinking, and practical application of theoretical knowledge. Findings suggested that the case method not only improved faculty members' pedagogical skills and confidence in active learning strategies but also led to unexpected outcomes, such as innovative, contextually relevant cases that bridged disciplinary silos and enhanced student engagement. Initial resistance to guideline uniformity across fields was a challenge, yet the process ultimately promoted professional growth and institutional teaching innovation. This study highlights the case method's potential as a scalable strategy for teacher professionalization in higher education and suggests implications for curriculum design and faculty training programs.

Keywords: *Case method, case-based learning, faculty professionalization, higher education, teaching effectiveness.*

1. Introduction

The case method is generally recognized as an effective teaching strategy in business, law, and medical training. However, there is limited evidence supporting its application in all fields of higher education (Rosier, 2022). Some studies suggests that case-based learning (CBL) is more effective than conventional teaching strategies because it enhances student engagement with learning processes, connects theory with practice, and fosters deeper understanding and critical thinking skills (Bonney, 2015; Delany et al., 2025; Mahdi et al., 2020; Varma et al., 2025).

Not only do students benefit from this strategy, but faculty do as well. Şen Akbulut & Hill (2022) and Ulvik et al. (2022) state that CBL encourages educators to transform from knowledge-transmitters to learning-facilitators. However, despite these advantages, the adoption of the case method beyond business, law and medicine remains limited, especially in social sciences, humanities, engineering, and education. This may be due to the predominant focus of research on student outcomes, with fewer studies exploring faculty experiences in developing and implementing cases, especially through interdisciplinary collaboration to create original, context-specific materials.

Higher education is undergoing a drastic transformation driven by the global and national trends and priorities (OECD, 2019), which have prompted universities to offer relevant education to their students. Yucatán, located in the southern of Mexico, has experienced an increasing migration of people from across the country. Consequently, private institutions have played a central role in serving these diverse student populations, whose presence provides rich material for case development. Unfortunately, as Villatoro et al. (2023) have suggested, faculty members frequently work in disciplinary silos, with limited structured opportunities for cross-disciplinary collaboration or professional development in innovative teaching methods.

The Modelo University (Unimodelo) is a private higher education institution with campuses in three cities: Mérida and Valladolid in the state of Yucatán, and Chetumal in the state of Quintana Roo. Unimodelo's educational approach is centred on human development, critical thinking, innovation, and social responsibility. The University comprises specialized schools of business, law, design, humanities, health, architecture, and engineering, offering a total of 25 undergraduate programs and 14 graduate

programs. With an enrolment of 3,200 students and 378 faculty members, Unimodelo seeks to prepare professionals to make significant contributions to society across the Yucatán Peninsula and beyond.
The present study is a big step forward for Unimodelo because it is the first time it has systematically documented the impact of encouraging faculty participation in a "Case Method" workshop not only to learn how to develop cases but to provoke interdisciplinary collaboration among members from different fields and schools. The objective was to analyse the impact of collaborative case development by faculty members from diverse disciplines on their professional growth and pedagogical transformation through three specific objectives:

1. Explore the experiences of the twenty-four faculty members who participated in the “Case Method” workshop and collaboratively designed cases.
2. Determine whether any teaching competencies were developed during the case method development process.
3. Identify the challenges faced during the process, the unexpected outcomes, and the potential for institutional adoption.

The findings indicate that the case method is a powerful vehicle for teacher professionalization, pedagogical innovation, and student engagement. They also demonstrate its potential for institutional application as a strategy to develop faculty teaching competencies and collaborative projects that transcend disciplinary boundaries.

2. Methodology

The study adopted a qualitative, interpretive approach grounded in constructivist paradigm, which facilitated an in-depth understanding of faculty experiences, with collective case-study design (Stake, 1995; Yin, 2018). The data-collection sources were: (a) Document analysis on the twelve cases using a seven-criteria-rubric: generalities, narrative, structure & organization, information & evidence, discussion engaging, composition, and excellence. (b) Semi-structured focus group interviews with participating faculty. The process unfolded in three phases: (1) Delivery of the “Case Method” workshop; (2) Collaborative case development. Faculty worked in interdisciplinary groups of two to four members; however, three faculty members whose areas of expertise were highly specialized chose to work individually. (3) Implementation of the cases.

2.1 Participants

Participation in the study was voluntary and encompassed two aspects: (a) the desire to engage in the “Case Method” workshop, and (b) the commitment to develop a case. All faculty from the seven schools at the Mérida campus were invited to participate. A total of twenty-seven people signed up to join the initiative, but twenty-four of them completed the whole process (see Table 1).

Table 1. Participants by school and field of expertise

School	Participants	Fields of expertise
Architecture	4	• Architecture (3) • Environment impact (1)
Law	4	• Ethics and Law (2) • Entrepreneurship (1) • Land use regulation (1)
Design	3	• Digital illustration and product design (2) • Neurodivergence (1)
Engineering	4	• Industrial Engineering (1) • Innovation (3)
Business	4	• Administration and Finance (2) • Business and Finance (2)
Health	5	• Sports medicine (2) • Clinical Nutrition (3)

2.2 Data Analysis

The data were analysed using Braun and Clarke's (2021) thematic analysis approach within a constructivist paradigm. Focus group interviews were audio-recorded and transcribed verbatim in Spanish before being imported into a secure document for analysis. The coding process, supported by Grok (xAI), comprised the following steps: (a) familiarisation with the transcripts through multiple readings and audio review; (b) inductive and deductive generation of initial codes based on the interview guide and emergent data; (c) collation of codes into candidate themes; (d) review and refinement of themes with peer debriefing for validation; and (e) definition and naming of final themes supported by illustrative quotes. The researchers oversaw the process, providing Grok with iterative prompts for coding suggestions, theme mapping, and pattern identification. This was followed by critical human review and adjustment.
Trustworthiness was enhanced through triangulation of the data from focus groups and document analysis of the twelve cases, checking of preliminary findings, and maintaining a detailed audit trail of the analysis process. To ensure the content validity of the seven-criteria rubric used for document analysis of the cases, the instrument was first aligned with the guidelines and template, as well as established literature on case-based pedagogy. The rubric was then piloted on two sample cases by the researchers and a peer expert in pedagogical innovation. Feedback from the pilot focused on the relevance, clarity, and comprehensiveness of the criteria.

3. Results

The results are presented in three sections. One shows the results of the three semi-structured focus groups interviews with the twenty-four faculty members. The other section shows the results of a systematic document analysis of the twelve cases.

3.1 Focus Groups Interviews

The focus groups interviews centred on seven main topics: motivation toward English, interdisciplinary collaboration, competency development, critical thinking, institutional follow-up, and artificial intelligence. The theme of collaborative networks also emerged in two of the focus groups. For better organization the results were grouped into four categories: (1) faculty workshop experience, (2) teaching competencies and interdisciplinary collaboration, (3) challenges and suggestions, and (4) implementation of the cases.

(1) Faculty workshop experience

They described the workshop experience as highly positive, rewarding, and transformative. They repeatedly emphasized how challenging it was to take a course in English language and yet how fluid, safe, and structured the course was. The English language issue was initially perceived as a limitation, but then it was seen as a challenging motivator. As one faculty member shared: *"What I remember most was the language challenge… it was difficult at first, but everything just started flowing, and it was a very rewarding, surprising experience."* (Group 1). Another noted, *"It was my first experience at the university taking a training course in English… it felt like gaining the confidence to speak."* (Group 2).

The faculty also valued the supportive atmosphere created by the instructor. They appreciated how the workshop broke down the traditional isolation between schools, allowed them to "get to know faces" and discovered their previously unrecognized expertise among their colleagues.

(2) Teaching competencies and interdisciplinary collaboration

The collaborative case development process increased teaching competencies. Faculty placed greater emphasis on scaffolding different levels of thinking (recognize, apply, analyse, propose). *"It helped me distinguish the levels of depth in thinking we want students to reach" (Group 2).* They affirmed having developed more reflective and critical assessments**,** moving away from memorization exams and toward activities that require students to argue and defend their ideas. *"I no longer give multiple-choice exams. They are now 100% reflective… it's about whether they defended their idea, not whether they think differently" (Group 2).* Another competency that the faculty said they developed was paying greater attention to real-world context (social, economic, multidisciplinary). *"I want them to develop this ability*

and not just stick to what they see in books, but to generate critical analysis based on the context in which they are living" (Group 3). Many faculty members reported implementing these new approaches in their courses during the semester following the workshop.

Similarly, interdisciplinary collaboration was another highly valued aspect. Faculty repeatedly expressed how valuable it was for them to "be forced" to work with colleagues from different fields. They said: *"It was such a diverse team… we approached it from the architectural perspective, the legal perspective, and the environmental engineering perspective… it was really cool." (Group 1).* Another mentioned: *"Although we share the same technical advisor, our areas of expertise are different; it helped me understand how others think… and we arrived at an interesting joint proposal." (Group 3).* Participants recognized that one of the greatest advantages of promoting interdisciplinary work is the possibility of developing richer and more contextualized cases, with broader, multifaceted perspectives and reduced bias. However, they also acknowledged scheduling difficulties, an initial preference for working with familiar colleagues, and occasional barriers related to disciplinary egos.

(3) Challenges and suggestions

The most prominent challenges participants identified were:

- The significant time required to design and implement case studies.
- Students' excessive reliance on artificial intelligence tools and reluctance to engage in deep analytical work.
- The lack of institutional follow-up or support after the workshop.

Participants also highlighted several positive, yet unexpected outcomes. These included increased confidence in using English in academic settings, strengthened networks between schools that led to new collaborative projects and a sense of professional renewal. Several faculty members also noted a powerful role model effect on their students. As one participant reflected: *"I could see… that I'm asking this of you, but I'm also making an effort as a teacher to do the same" (Group 2).* Faculty expressed enthusiasm to continue and expand the initiative and offered practical suggestions for scaling the project:

- A version 2.0 of the workshop that includes ongoing support during case implementation in classrooms.
- Creation of an institutional repository of teaching cases.
- Formal institutional incentives, such as academic credit, reduced teaching loads, or a points-based recognition system.
- Regular technical-pedagogical English courses tailored for faculty.
- Development of formal multidisciplinary projects with institutional follow-up and stronger links to industry, government, and the local community.

Some participants offered the following quotes in this regard: *"It would be great if we could have some kind of guidance or support… to help us bridge the gap, because we're ready to move to the next level" (Group 2)*. Another suggested, *"If there's a model project… let a group be selected… and give them the assignment that they'll have a year to work on it" (Group 3).*

(4) Implementation of the cases

Some participants mentioned that the implementation of the cases revealed certain discrepancies between what they planned and how it was applied. The findings in this regard were organised into three categories, as shown in Table 2.

Table 2. Frequency of faculty comments on the implementation of cases per category

Category	Frequency
Implementation issues	18
Barriers and facilitators	15
Impact on students	14

The majority of participants reported feeling rushed because they did not feel ready. They had to adapt their approach during the implementation, incorporating new perspectives, reflective questions, ludic dynamics and role-playing, as the students were not responding as expected. However, these modifications helped to engage them. With regard to barriers, the time required to rethink activities was cited as the most frequent difficulty, followed by managing students' reliance on AI and the lack of post-workshop support. The guidelines provided during the workshop and academic freedom, however, were ideal facilitators for making quick changes to adapt to students' needs and characteristics. Some faculty observed benefits that enriched the learning experience in students. They (the students) demonstrated higher levels of engagement and participation, moving beyond the theoretical content to actively analyse real scenarios. The faculty shared some comments from students about their experiences with the cases developed in class. These comments have been translated verbatim into English, with the original meaning, tone and intent preserved as closely as possible.

- Student A. *Personally, ma'am, I thought they were good, because basically we bring reality into the classroom, and I find that quite interesting and enriching, because we work with real-life cases, real solutions, and basically situations that could happen in real life, not just the educational activities that are typically used in classrooms.*

- Student B. *Basically, what I took away from them was how to solve real-life problems and to work with a different mindset, one that isn't as methodical as what we're taught in the classroom.*

- Student C. *I believe that these case studies help us approach the subject matter using logic that's more closely aligned with the situation at hand. Positive aspects include that they challenge us to delve deeper into our analysis and offer new perspectives. An area for improvement could be to approach them with a more structured framework. They allow me to grasp the complexity of this type of project and also to tackle seemingly overwhelming tasks step by step.*

3.2. Document Analysis of Cases

The cases were analysed using a seven-criteria rubric (generalities, narrative, structure & organization, information & evidence, discussion engaging, composition, and excellence), each criterion could be scored on a scale from 4 (proficient) to 1 (deficient) scale, yielding a maximum of 28 points; the total was converted to a 100-point scale. The rubric was designed in accordance with the guidelines employed in the Case Method workshop, and the template used to develop their own cases. This approach enabled the establishment of a standard against which cases could be evaluated.
The cases were rated from 57 to 93 out of 100 with an average rating of 77.5. Eight cases (66%) demonstrated proficiency, while three cases required substantial revision and improvement. Most cases (83%) exhibited strengths particularly in the structure & organization criterion showing a clear and logical structure with well-defined sections and coherent flow. It's worth noting that a 100% of cases were developed considering the local context issues of Yucatán such as beach land dispossession, neurodiversity in the classroom, child abuse, ethical dilemmas in outsourcing and financial decisions, among others. In addition to considering global issues in a local context, nine of the twelve cases (75%) were developed by interdisciplinary teams. These cases featured realistic narratives, strong integration of evidence and a successful effort to incorporate different analytical perspectives, with bilingual (English-Spanish) versions.
Furthermore, a review of the cases revealed common weaknesses. The most prevalent, identified in 92% of cases, was the lack of alignment among three primary components that ensure consistency across cases: the line of reasoning (inductive or deductive), the discussion questions, and the anticipated learning outcomes. The majority of discussion questions had a high degree of bias or answers readily apparent, limiting the potential for critical thinking. Furthermore, the instructions for the final assignment were frequently ambiguous or even absent. Other issues were also identified such as grammatical errors, formatting inconsistencies, and non-adherence to the institutional template.

4. Discussion

The findings of this collective case study confirm that the faculty-led initiative for the collaborative development of teaching cases had a positive and significant impact on the pedagogical training of the twenty-four participants. Both the focus group transcripts and the document analysis of the cases reveal

a highly valued experience, in which the challenge of the English language served as a motivational catalyst and interdisciplinary work enriched the perspectives of the cases.
These results align with the constructivist approach (Stake, 1995; Yin, 2018) which emphasizes how collaborative work can achieve profound changes in practice (Braun & Clarke, 2021). The triangulation of data was consistent. While faculty reported improving their teaching competencies in designing cases, structuring activities, and promoting critical thinking, case analysis evidenced well-structured development. The content addressed global issues while being grounded in a local context. Interdisciplinary collaboration strengthened this approach by enabling analysis of one case from different perspectives. In addition, the identified weaknesses serve as evidence of the efficacy of the workshop, the collaborative efforts of the faculty with colleagues from diverse fields, and the design of one case study to be analysed from multiple perspectives.
The interdisciplinary collaboration is a pivotal finding of the study. This collaboration has been shown to improve case quality and foster professional networks. Furthermore, it has been demonstrated to reduce isolation among schools and enable innovative and disruptive work methods. This finding reinforces Modelo University's vision as an institution that promotes collaborative work beyond disciplinary boundaries. It's no wonder the institutional follow-up that the faculty requested will be granted.

5. Conclusion and Recommendations

This study shows that the faculty-led initiative for the collaborative development of cases successfully achieved its three main objectives. The twenty-four participating faculty members experienced a positive yet challenging Case Method workshop, and the collaborative design of cases represented a great opportunity to break boundaries (Objective 1). The experience of designing cases and working interdisciplinarily strengthened their teaching competencies in designing activities, promoting critical thinking among students, and evaluating beyond memorization (Objective 2). Finally, they produced relevant cases that address global issues in local contexts and have great potential for institutional adoption (Objective 3).
Integrating Case Method training, English-language practice, and interdisciplinary collaboration has resulted in a robust intervention capable of fostering significant pedagogical renewal in higher education settings, particularly at Modelo University. However, the study also revealed important areas for improvement that require institutional attention to fully consolidate and scale the initiative's impact. To build on the current success, the following actions are recommended:

- Implement Version 2.0 of the workshop that includes support during the classroom implementation along with peer review sessions and formative feedback.
- Create an institutional database of standardized cases, using the official institutional template and classified by educational level, discipline, and type of reasoning.
- Establish formal institutional incentives such as academic credit, teaching load reduction (time off), or a points-based system to encourage sustained faculty participation.
- Strengthen the teaching competencies and the English component through permanent training programs that preserve the practical and confidence-building approach of the original workshop.
- Design institutional multidisciplinary projects that connect schools and, when possible, external stakeholders (industry, government, and community), with structured follow-up and dissemination of results.
- Provide training on the ethical and pedagogical use of artificial intelligence (AI) to guide faculty toward responsible AI practices.

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Pre-service Teachers' Solution Strategies in Addition and Subtraction Tasks

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Abstract

Specialized content knowledge (SCK) concerns the mathematics teacher's deeper understanding of the specific mathematical topics to be taught ([1]). Flexibility refers to the ability to use a variety of strategies to solve mathematical problems, while adaptivity refers to the selection and use of strategies that are appropriate for a given task ([2]). In this study, we examine which solution strategies first-year pre-service teachers in the primary school teacher education program use when solving addition and subtraction tasks. We asked 22 pre-service teachers to complete a test consisting of addition and subtraction tasks toward the end of their first semester in the teacher education program. The test was analyzed using a thematic qualitative analysis strategy ([3]). The theoretical framework applied in the study was based on the solution strategies for addition and subtraction with multi-digit numbers described by Hickendorff et al. (2019) ([4]). Our results indicate that most pre-service teachers in the primary school program used algorithm-based solution strategies when solving addition and subtraction tasks, while only a small proportion used the number line as a strategy. The findings highlight the importance of strengthening representational competence and conceptual understanding in the early stages of teacher education ([5]; [2]). In particular, the number line, central in the Norwegian curriculum and foundational for understanding number relations, should be emphasized not only as a pedagogical tool for young students but also as a representational resource for future teachers' own mathematical reasoning.

Keywords: *Solution strategies, Pre-service teachers, Addition and Subtraction Tasks, Specialized content knowledge*

1. Introduction

Ball et al. (2008) ([1]) developed a model describing the knowledge required by mathematics teachers, consisting of two main domains: subject matter knowledge and pedagogical content knowledge. Within the domain of subject matter knowledge, the model distinguishes between common content knowledge and specialized content knowledge. Common content knowledge refers to the mathematical knowledge needed to solve mathematical problems and includes the fundamental mathematical skills that are taught in school ([6]). Specialized content knowledge (SCK), on the other hand, concerns the mathematics teacher's deeper understanding of the specific mathematical topics to be taught. This includes, among other aspects, the ability to provide explanations that are comprehensible and useful for students, to represent mathematical ideas and relationships in appropriate and accessible ways, and to solve mathematical problems using multiple approaches ([6]).

The development of flexibility and adaptivity has become a central goal of arithmetic instruction in primary school ([2]). Flexibility refers to the ability to use a variety of strategies to solve mathematical problems, while adaptivity concerns the selection and use of strategies that are appropriate for a given task ([2]). Lin et al. (2011) ([5]) suggest that specialized content knowledge (SCK) consists of three components: representation, justification, and explanation. Representation involves the accurate and effective selection and use of mathematical representations; justification concerns the description and justification of mathematical ideas; and explanation refers to providing mathematical expressions of common rules and procedures. In this study, we focus specifically on representations, more precisely, on the solution strategies used by pre-service teachers.

According to the Norwegian national curriculum (LK20), students are introduced to addition and subtraction in Grades 1 and 2, multiplication in Grade 3, and division in Grade 4 ([7]). One of the competence aims for Grade 2 states that students should use the number line when solving addition and subtraction tasks. In addition, students are expected to explore the commutative and associative properties of addition. At Grade 3, a competence aim emphasizes that students should use appropriate strategies for subtraction in practical situations.

These curriculum requirements imply that mathematics teachers working in Grades 1–7 need strong knowledge of a variety of solution strategies for addition and subtraction tasks. Accordingly, the aim of this study is to investigate the following research question: **Which solution strategies do pre-service teachers in the Grades 1–7 teacher education programme use when solving addition and subtraction tasks early in their teacher education?** To address this research question, pre-service teachers enrolled in the Grades 1–7 programme were asked to solve 22 addition and subtraction tasks at the end of their first semester in teacher education. The students' solutions were analyzed using the solution strategy framework described by Hickendorff et al. (2019) ([4]), and the results are discussed in relation to previous research on the solving of addition and subtraction problems.

2. Theory

The model of Mathematical Knowledge for Teaching (MKT) developed by Ball et al. (2008) ([1]) conceptualizes the knowledge teachers need into two main dimensions: subject matter knowledge and pedagogical content knowledge. Specialized content knowledge (SCK) constitutes one of the three categories within subject matter knowledge and is defined as mathematical knowledge that is specific to the work of teaching. Delaney et al. (2008) ([8]) describe specialized content knowledge as the mathematical knowledge and skills that teachers use in instructional contexts.
Morris et al. (2009) ([9]) suggest that SCK is a particularly suitable focus area for pre-service teacher education. Moreover, SCK is considered essential for effective classroom instruction. In this sense, teachers and pre-service teachers should be able to accurately represent mathematical ideas, provide explanations for common rules and procedures, and examine, interpret, and understand non-standard or unusual solution methods ([10]). Similarly, Petrou and Goulding (2011) ([11]) define SCK as the type of mathematical knowledge teachers and pre-service teachers require for effective mathematics teaching and for use in classroom practice.
Mitchell et al. (2013) ([12]) examined teachers' classroom practices and emphasized that the use of representations is essential in the teaching of integers. They also developed a typology of tasks involving the use of representations in integer instruction. The use of representations is particularly important when dealing with integer operations, as the properties of these operations are often challenging for students. Stephan and Akyüz (2012) ([13]) point out that integer operations pose specific representational challenges because, unlike natural numbers, students cannot construct meanings for integer operations solely through abstraction from concrete objects.
Addition is defined as an operation in which the sum of two numbers results in a third number that contains as many units as the two numbers combined, and it is symbolized by the plus sign (+) ([14]). The two numbers are referred to as addends, expressed as *addend* + *addend* = *sum* ($a + b = c$). Subtraction, on the other hand, is the operation or process of finding the difference between two numbers using the minus sign (–). When the sum and one addend are known, the operation used to find the unknown addend is subtraction. Subtraction is therefore the inverse operation of addition ([14]), and a subtraction task can be expressed as *minuend* – *subtrahend* = *difference* ($a - b = c$).
Over the past decades, the development of flexibility and adaptivity has become a central goal in the teaching of arithmetic in primary education ([2]). Flexibility refers to the ability to use a variety of strategies to solve mathematical problems, while adaptivity concerns the selection and use of strategies that are appropriate for a given task ([2]). In a study by Körner et al. (2026) ([15]), the authors investigated how 91 pre-service teachers early in their education and 91 pre-service teachers at the end of their education solved addition and subtraction tasks on a test. The results showed that many pre-service teachers at the beginning of their education struggled with flexible and adaptive calculations, whereas pre-service teachers nearing the end of their education demonstrated greater flexibility and adaptivity in their solution strategies.
A key characteristic of solution strategies for multi-digit numbers is whether the calculation is based on place value or not. This distinction results in two main types of strategies: *number-based strategies* and *digit-based strategies* (cf. [16]). In number-based strategies, the place value of digits is respected (for example, the number 83 is decomposed into 80 and 3). In contrast, digit-based strategies ignore place value, treating numbers as sequences of individual digits (for example, decomposing 83 into the digits 8 and 3 without considering that 8 represents eight tens, or 80). The most common digit-based strategies are the written algorithms for addition, subtraction, multiplication, and division, which operate on single digits in a proceduralized manner, typically from right to left.
Hickendorff et al. (2019) ([4]) describe both number-based and digit-based strategies for multi-digit addition and subtraction. One dimension for categorizing strategies concerns the underlying operation of the solution process: addition or subtraction. In multi-digit addition, there is only one operational

approach, direct addition, where one addend is added directly to the other. In contrast, multi-digit subtraction can be performed in three different ways: as direct subtraction, where the subtrahend is taken away from the minuend; as indirect addition, where one adds on from the subtrahend until the minuend is reached (also referred to as an addition strategy); and as indirect subtraction, where the difference is determined by calculating how much must be taken away from the minuend to reach the subtrahend.

The number-based strategies include sequential strategies, decomposition strategies, varying strategies, and the column-based strategy. In sequential strategies (also known as jump strategies), numbers are primarily viewed as positions on a (mental) number line, and operations involve forward or backward movements along this number line. In decomposition strategies (also referred to as split strategies;[17]), numbers are conceptualized according to their decimal structure, and operations involve partitioning or splitting numbers into place-value-based components. Varying strategies involve adapting numbers and/or operations in the problem, such as in compensation strategies where one operand is rounded to a more convenient number (e.g., subtracting 70 instead of 69 and then compensating by adding back the extra 1 that was subtracted).

The column-based strategy largely relies on the same numerical approach as decomposition strategies but is explicitly taught as a separate strategy in Dutch Realistic Mathematics Education (RME). It functions as an intermediate or hybrid strategy that bridges number-based strategies and digit-based algorithms. On the one hand, it operates with numbers rather than digits; on the other hand, it follows a standardized step-by-step procedure accompanied by a structured vertical notation.

Column-based strategies therefore represent a specific form of number-based strategies designed to facilitate a smoother and more conceptually meaningful transition between number-based strategies and digit-based algorithms (cf. [18]). Although these strategies share features with digit-based algorithms, such as the use of structured vertical notation, they operate on whole numbers rather than digits and proceed from left to right, which clearly distinguishes them from digit-based algorithms.

In most countries, digit-based algorithms fall under the category of direct addition or subtraction. The key difference from number-based strategies is that numbers are treated as individual digits, thereby ignoring their place value. For example, in a digit-based addition strategy, one begins by adding the units (e.g., 8 + 6 = 14), writes down the 4, carries the 10 as a 1, and then adds the tens digits (e.g., 3 + 4 + 1 = 8). Only after combining the resulting digits does the 8 come to represent eight tens. Digit-based addition and subtraction algorithms proceed from right to left, starting with the units, followed by the tens, and so on.

Table 1. Different solution strategies for multi-digit addition and subtraction tasks (Hickendorff et al., 2019)

Arithmetic operation	**Type**	**Number-based strategy**				**Digit-based strategy**
		Sequential	**Dekomposisjon**	**Variert**	**Colum-based**	
Addition Example 38 + 46	Direkt addition	38+40=78; 78+6=84	30+40=70; 8+6=14; 70+14=84	38+50=88; 88-4=84	38 46+ 70 14+ 84	1 38 46+ 84
Subtraction Example 82 - 69	Direkte subtraction	82-60=22; 22-9=13	80-60=20; 2-9=-7; 20-7=13	Eksempel, kompensasjon: 82-70=12; 12+1=13	82 69- 20 -7 13	7 10 82 69- 13
	Indirekt addition	69+3=72; 72+10=82; 3+10=13	9+3=12; 60+10=70: 3+10=13	69+1=70; 70+12=82; 1+12=13		
	Indirekt subtraction	82-10=72; 72-3=69; 10+3=13	80-10=70; 2-3=-1; 10+3=13	82-20=62; 62+7=69; 20-7=13		

In sequential strategies (also referred to as *jump strategies*), numbers are primarily conceptualized as objects on a number line. Number lines reveal the ordinal meaning of numbers, while counters reveal their cardinal meaning. Davidson (1987) ([19]) therefore emphasizes the importance of understanding both ordinal and cardinal meanings of integers in the conceptualization of number concepts. From this

perspective, both teachers and pre-service teachers need a deep conceptual understanding of why and how addition and subtraction with integers are performed.
For example, Griffin et al. (1995) ([20]) identified knowledge of number order, such as that represented on a number line, as a crucial foundation for the development of other number concepts. Their study showed that low-performing students who received explicit instruction using number lines were able to catch up with high-performing students in mathematics. Similarly, participants in the study by Bofferding et al. (2013) ([21]) were able to use movements on a number line to add or subtract positive integers from negative integers. However, they did not successfully use the number line to add or subtract negative integers, suggesting that number line instruction needs to address such situations more explicitly and effectively ([21]).
Ipek (2018) ([22]) investigated pre-service teachers' specialized content knowledge related to addition and subtraction. In this study, 42 fourth-year pre-service teachers solved 16 addition and subtraction problems and subsequently participated in interviews. When the pre-service teachers' representations, justifications, and explanations were analyzed collectively, the findings indicated that they lacked sufficient subject matter knowledge. The number line is an early numerical representation that can be strategically used by teachers to develop students' understanding of number magnitude and arithmetic operations ([23]). Number lines support accurate counting, comparisons of number magnitude, and computational processes, and one of their key advantages is that they help connect mathematical content across grade levels ([23]).
When comparing pre-service teachers' representational abilities, Ipek (2018) ([22]) found that the number line was the representation they struggled with the most, whereas counters were the representation they used most successfully. This finding aligns with earlier research, which also reported counters to be more effective than number lines. Finally, the results showed that pre-service teachers primarily focused on procedural or operational knowledge when explaining integer addition and subtraction. According to Skemp (1976) ([24]), symbolic presentations of integer operations that are not connected to meaningful contexts reflect *instrumental understanding*, which may contribute to rote learning. From this perspective, the appropriate use of number lines and counters, combined with meaningful contexts, is crucial for fostering relational or conceptual understanding of integer operations.

3. Method

This study involved 22 pre-service primary school teachers enrolled in the Grades 1–7 teacher education programme during their first semester. The participants completed a written test consisting of 22 tasks on addition and subtraction involving integers. Examples of the test tasks are presented in Table 2.
The students' written solutions were analyzed in order to identify the solution strategies they used when solving the tasks. The strategies (see Table 1) were identified through a qualitative thematic analysis, following the approach described by Braun and Clarke (2013) ([3]). In the analytical process, the students' responses were categorized according to the solution strategy framework proposed by Hickendorff et al. (2019) ([4]) (see Table 1).

Table 2. Examples of tasks from the test

Task	Task description	Answer	Mathematical content
4	-20 + 15 = ____	Svar: -5	Addend + Addend = Sum Unknown sum; two-digit numbers; one addend is negative.
5	– 4 + ____ = 10	Svar: 14	Addend + Addend = Sum Unknown addend; the other addend is negative; the sum is positive.
6	___ + 13 = -5	Svar: -18	Addend + addend = sum. Unknown addend; the other addend is positive; the sum is negative.
7	– 8 + (-7) = _____	Svar: -15	Addend + addend = sum. Unknown sum; two single-digit negative addends; sign rules.
8	___ + (-9) = - 16	Svar: -7	Addend + addend = sum. Unknown addend; the other addend is negative; the sum is negative.
9	– 5 – 4 = ____	Svar: -9	Minuend − subtrahend = difference. Unknown difference; the minuend is negative.
10	2 – (-3) = ____	Svar: 5	Minuend − subtrahend = difference.

			Unknown difference; the subtrahend is negative.
11	____ - 8 = - 5	Svar: 3	Minuend − subtrahend = difference. Unknown minuend; the minuend is positive.

4. Analysis and Results

The analysis was conducted by following the deductive–thematic approach described by Braun and Clark (2013) ([3]). Each student solution was coded using the predefined strategy categories from Hickendorff et al. (2019) ([4]). This step allowed us to describe the distribution of strategy types across the 22 tasks. After that we examined patterns in the coded material to identify broader themes in the pre-service teachers' strategy use.
We entered the categories and codes we used from Hickendorff et al. (2019) ([4]) into an analysis form, Table 3. The analysis form provided an overview of how the pre-service teachers responded to the different tasks.

Table 3. The categories in the analysis

Category	**Not answered**	**Number-based strategies**				**Digit-based algorithm**
Code		**Seq**	**Dec**	**Var**	**Col**	**Algorithme**
Numerical value	0	1	2	3	4	5

The results of the analysis are summarized in Table 4, which presents the percentage distribution across the different categories for each task.

Table 4. Response rate to the different tasks

Tasks	**1**	**2**	**3**	**4**
1	18,18 %	0	54,54 %	22,27 %
2	13,63 %	0	63,63 %	18,18 %
3	9,10 %	4,54 %	59,1 %	18,18 %
4	68,18 %	0	13,63 %	4,54 %
5	63,63 %	0	22,72 %	9,1 %
6	50 %	0	18,18 %	18,18 %
7	40,9 %	0	27,27 %	18,18 %
8	40,9 %	0	18,18 %	22,27 %
9	59,1 %	0	18,18 %	9,1 %
10	31,81 %	0	13,63 %	27,27 %
11	45,45 %	0	13,63 %	18,18 %
12	27.27 %	0	4,54 %	50 %
13	4,54 %	9,1 %	45,45 %	31,81 %
14	4,54 %	18.18 %	40,9 %	31,81 %
15	9,1 %	0	22,27 %	45,45 %
16	9.1 %	0	22,27 %	45,45 %
17	13,63 %	0	4,54 %	77,27 %
18	13.63 %	0	4,54 %	77,27 %
19	18,18 %	0	0	77,27 %
20	13,63 %	4,54 %	4,54 %	68,18 %
21	13,63 %	4,54 %	4,54 %	68,18 %
22	9,1 %	9,1 %	0	68,18 %

4.1 Distribution of Strategies Across Tasks

Table 4 summarizes the frequency of strategy categories for each of the 22 tasks. Across the dataset, a clear pattern emerged: an algorithm-based strategy was the most frequently used, particularly in the later tasks of the test. Several tasks (e.g., tasks 17–22) show algorithm use by more than two thirds of the students, with task 19 reaching 77.27%.
In contrast, number-based strategies were used far less frequently. Among these, sequential strategies (which often indicate a number line approach) were almost absent. Only a small number of students

used sequential reasoning on any tasks, and often only 1–2 students per task (e.g., 4.54% on several tasks). Importantly, for the tasks specifically suited to number line reasoning (tasks 4–11), the expected increase in sequential strategies did not occur. For instance, task 4 (−20 + 15) and task 5 (−4 + __ = 10) yielded 0% sequential strategies, despite being tasks that could naturally invite a jump strategy on the number line. A second notable pattern is the high rate of non-response on early negative-number tasks (tasks 4–11). Several of these tasks show non-response rates between 40% and 68%.
The structure of the tasks appears to influence the strategy choices. In the early tasks (especially tasks 1–3), a noticeable subset of pre-service teachers applied decomposition strategies (e.g., 54.54% in task 1), but as the test progressed, this category decreased sharply. In contrast, the last six tasks (17–22) show a strong concentration of algorithm use (68–77% across all tasks), suggesting that many students rely on procedural fluency rather than conceptual flexibility. The near absence of varied strategies (e.g., compensation) reinforces this interpretation.

5. Discussion and Didactics Implications

This study examined the solution strategies used by first-year pre-service teachers when solving addition and subtraction tasks. Using a deductive thematic analysis based on the framework of Hickendorff et al. (2019) ([4]), we found that the majority of students relied primarily on algorithmic-digit based strategy across the 22 tasks. Number-based strategies, including sequential, decomposition, and varied approaches, were used far less frequently, and strategies directly connected to number line reasoning appeared only sporadically.
The clear predominance of algorithm-digit based strategy across the majority of tasks indicates that the pre-service teachers, at the beginning of their teacher education, have an poor flexibility and adaptive solution strategies in addition and subtraction tasks. This agrees well with what Körner et al. (2026) ([15]) found in their study. While fluency with standard algorithms is an important component of a teacher's mathematical repertoire, it does not, by itself, constitute specialized content knowledge ([1]). Such knowledge includes the ability to explain procedures conceptually, use and justify alternative strategies, and make explicit connections between representations.
The analysis across tasks shows that the vast majority of students stuck consistently to one strategy type, most often the algorithm-digit based strategy, regardless of task structure. Very few students demonstrated intra-individual variation, an indicator of adaptive expertise in arithmetic. This reinforces the interpretation that many students rely on memorized procedures rather than conceptual reasoning or strategic adaptation. The almost complete absence of intra-individual flexibility across the tasks reinforces this interpretation. Most students used the same strategy type throughout the test, regardless of the structure or complexity of the problem. This is in contrast to earlier research showing that flexible strategic adaptation is characteristic of mathematically proficient learners and a hallmark of expert teaching ([2]). Limited flexibility suggests that these students may struggle to choose strategies purposefully or to demonstrate the variety of methods they will be expected to model in their future classrooms.
We found that number-based strategies were used far less frequently than an algorithm-based strategy. Despite the documented importance of the number line as a foundational representational tool, supporting understanding of magnitude, structure, continuity, and relationships among numbers, only a small number of pre-service teachers employed number line, related (sequential) strategies. This finding is notable because several of the tasks (especially items 4–11 involving negative numbers and missing addends) were well-suited to such reasoning.
Despite the central role of the number line in the Norwegian curriculum ([7]) and in conceptual understanding of number and operations ([19]), only a handful of pre-service teachers used sequential (jump) strategies. Even when tasks were structurally suited for number line reasoning (tasks 4–11), students overwhelmingly chose algorithms or left the task blank. This suggests that the students may not consider the number line a natural or accessible representation when solving arithmetic tasks involving negative numbers. This interpretation aligns with previous studies reporting that pre-service teachers often associate the number line with early counting activities rather than with general mathematical reasoning or structure. If the number line is not perceived as a meaningful tool in their own reasoning processes, it is unlikely that they will use it purposefully in classroom instruction.
The high non-response rates on several items involving negative numbers suggest additional conceptual difficulties. Previous research has identified operations with negative integers as a persistent challenge even for teachers and pre-service teachers' ([22]; [21]; [20]; [16]), and the pre-service teachers' omission patterns in this study reflect this. A lack of representational strategies, such as using a number line to visualize additive inverses or directionality on the continuum, may contribute to this

difficulty. This also connects to Ball et al.'s (2008) ([1]) notion of specialized content knowledge: teachers must not only be able to compute with negative numbers but also to explain *why* their procedures work and to choose representations that make the concepts accessible to students. Weaknesses in the students' use of the number line therefore indicate more than a representational gap; they suggest limitations in deeper structural understanding of integer arithmetic ([9]; [10]; [11]; [8]).

The findings highlight the importance of strengthening representational competence and conceptual understanding in the early stages of teacher education ([5]; [2]). In particular, the number line, central in the Norwegian curriculum and foundational for understanding number relations, should be emphasized not only as a pedagogical tool for young students but also as a representational resource for future teachers' own mathematical reasoning. Developing flexible strategy use, and a deeper understanding of the structure of operations with both positive and negative numbers, should be integral goals within the mathematics education of pre-service teachers.

Overall, this study suggests that while pre-service teachers may enter teacher education with strong procedural fluency, they require further support to develop the conceptual and representational knowledge necessary for high-quality mathematics teaching. Future research could examine how targeted instruction on number line representations and flexible strategy use influences pre-service teachers' mathematical reasoning over time.

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Storytelling for Teachers' Professional Development. Narrative Reflections on In-Service Teacher Training Pathways

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Abstract

As part of the initiatives linked to the PNRR, Ministerial Decree 66/2023 has been a key milestone for schools in promoting a system of continuous professional development for Italian teachers, with the aim of strengthening their professional, pedagogical and digital skills with a view to innovative and reflective teaching. In this context, the need to recount experiences from different perspectives offers one way of capturing the complexity of adult learning and teachers' professional development. The personal and professional narrative of training, viewed through the eyes of the trainer, emerges as a methodological tool for promoting transformative learning and teachers' professional identity. The approach proposed in this paper is based on Narrative Inquiry and narrative-oriented practices, which develop an interconnected framework between narration, guidance and the development of educational practices. The process of reflection and support that uses stories and narratives to foster the construction of meaning and skills in training contexts reveals positive effects on equity and professional motivation among both teachers and trainers. The experience described here represents an attempt to share structured narratives (logbooks, memes, critical reflections) analysed according to an integrated narrative model, inspired by Narrative Inquiry as a research methodology.

Keywords: *Narrative Inquiry; Teacher professional development; Continuing professional development; Transformative learning; Innovative teaching methods*

1. Introduction

As part of the initiatives under the National Recovery and Resilience Plan (PNRR), Ministerial Decree 66/2023 marked a significant step forward in promoting the continuous professional development of school staff, with a focus on enhancing teachers' professional, pedagogical and digital skills. The decree frames professional development within a context of educational innovation and organisational transformation, emphasising collaborative and reflective models of professional learning that are consistent with lifelong learning.

From this perspective, teacher training is not merely a matter of professional updating, but constitutes a process of identity construction and the transformation of educational practices. International literature indeed highlights the link between professional development, reflection on experience and participation in professional learning communities (Schön, 1983; Wenger, 1998; Sachs, 2021). Through narration, individuals attribute meaning to experience and construct forms of knowledge that guide action (Bruner, 1988, 1991). Training thus takes on a relational and narrative dimension, in which learning emerges from the exchange of situated experiences and practices.

Recent European education policies have placed greater emphasis on training models based on reflection, collaboration and the integration of digital skills. In particular, the DigCompEdu framework highlights the need to develop forms of professional learning capable of integrating the technological, pedagogical and critical dimensions of teaching professionalism (Redecker, 2022; Ceccacci, 2022). At the same time, educational research emphasises the importance of structured spaces for shared reflection, in which teachers can collectively interpret their professional experience (Di Donato & De Santis, 2021a; Darling-Hammond et al., 2023).

This paper focuses not on the narratives of the participating teachers, but on the reflective experience of the trainers who designed and observed the training programmes. Their narratives constitute a reflective meta-narrative that allows us to view training as a relational ecosystem, in which the trainers themselves also construct professional knowledge through observation, discussion and the re-elaboration of experience.

The approach adopted is based on Narrative Inquiry, a qualitative methodology focused on the study of lived experience through narratives (Clandinin & Connelly, 1997, 2000; Ceccacci, 2020). Narrative takes

on an epistemic function, as it facilitates processes of interpretation, understanding and the attribution of meaning to experience. This perspective engages with studies on Transformative Learning, which attribute a central role to critical reflection in the revision of interpretative and professional frameworks (Mezirow, 2003), and with the literature on Communities of Practice, which interprets professional learning as a social process of participation and negotiation of meanings (Wenger, 1998; Fabbri, 2014; Di Donato & De Santis, 2021a).
The research aimed to document how training experiences prompted the trainers to reflect on their professional identity, the effectiveness of teaching approaches and the dynamics of peer interaction. The paper therefore offers a methodological and pedagogical reflection on the value of Narrative Inquiry in teacher training, highlighting how narrative reflection can serve not only as a tool for analysing experience, but also as a practice that fosters continuous professional learning.

2. Theoretical Framework

Narrative Inquiry is one of the main qualitative approaches for investigating educational and professional experience. According to Clandinin and Connelly, storytelling enables individuals to attribute meaning to their experiences over time and within social contexts, thereby facilitating the construction of professional identity. Narrative knowledge is not limited to the description of events; rather, it enables an understanding of how individuals interpret and reorganise their professional experience. Riessman (2008) also highlights the interpretative and relational nature of narration, whilst other authors (Barkhuizen, 2014) emphasise its value in teacher education contexts, where professional stories become tools for self-reflection. In the present study, narration serves a dual function: as a means of collecting qualitative data and as a space for reflection through which the trainers critically process their own professional experience. Professional reflection is a central element of continuous professional development. Schön (1983) interprets professionalism as the ability to reflect on action and within action, developing forms of situated knowledge that are useful for addressing the complexity of educational practices. The perspective of transformative learning broadens this dimension, highlighting how critical reflection facilitates the revision of interpretative and professional frameworks through the reinterpretation of experience (Mezirow, 2003). From this perspective, training takes on a transformative function insofar as it promotes critical awareness and the re-elaboration of professional meanings. In the context of this research, reflexivity concerns the trainers, who are engaged in the observation and critical re-examination of their own training practices. Professional learning is also interpreted through the lens of Communities of Practice (Wenger, 1998). The shared narrative practices among trainers have triggered collaborative processes of interpreting experience, shaping a professional space in which training knowledge is collectively constructed and redefined. Research on Professional Learning Communities confirms that collaboration and shared reflection are fundamental conditions for sustaining lasting transformations in educational practices (Di Donato & De Santis, 2021b; Stoll et al., 2023; Zhang et al., 2024).
Finally, this contribution is situated within the framework of practitioner inquiry, which views education professionals not only as recipients but also as producers of professional knowledge (Cochran-Smith & Lytle, 2009). From this perspective, the trainers' narrative reflection is interpreted as a practice of professional inquiry aimed at the critical understanding of training practice and the shared construction of professional meanings.

3. Methodology

The research takes the form of a qualitative study using the Collaborative Narrative Inquiry approach, aimed at gathering reflections arising from the trainers' experience in organising and delivering teacher training courses carried out under Ministerial Decree 66/2023. The methodological approach adopted is based on the idea that professional knowledge emerges through processes of narration, reflection and shared interpretation of experience (Clandinin & Connelly, 2000). The research design therefore adopts an interpretative and reflective perspective, consistent with qualitative approaches aimed at understanding the meanings attributed to professional experience (Creswell & Poth, 2018).
Between June 2024 and September 2025, the two trainers designed and delivered 111 training courses, all within the thematic area of digital transition, both face-to-face (45.9%) and remotely (49.5%), covering almost all Italian regions. The courses were aimed at school staff from both comprehensive schools (60.4%) and higher education institutions (39.6%).



Fig. 1. Generated using Claude (Anthropic, 2026)

The map shows the distribution of schools: comprehensive schools (primary and lower secondary schools) are highlighted in green, whilst upper secondary schools are shown in purple. The trainers delivered a total of 111 courses, of which 55 were face-to-face workshops and 51 were online courses. A total of 1,714 teachers took part.

From an epistemological perspective, Ministerial Decree 66/2023 adopts the European DigCompEdu framework as a binding scientific and methodological matrix for the standardisation of training courses, moving beyond the ad hoc use of technologies in favour of the systematic development of professional digital competences. In line with this regulatory framework, the research design adopts the multidimensional structure of DigCompEdu, organised into six strategic competence areas, in light of the taxonomic progression of proficiency levels set out in the framework (from Novice-A1 to Pioneer-C2):

Area 1: Professional Engagement; Area 2: Digital Resources; Area 3: Teaching and Learning; Area 4: Assessment; Area 5: Empowering Learners; Area 6: Facilitating Learners' Digital Competence.

Segmentation was initially used to identify the training needs of the sample of teachers involved in the research, by assessing their self-perception of digital competences and identifying the main gaps in those areas of DigCompEdu most in need of methodological support. The data collected made it possible to define training priorities and to structure the subsequent quantitative and qualitative analysis protocols.The materials were treated as qualitative data of a narrative nature, useful for capturing both the trainees' self-perception of their skills and the interpretations developed by the trainers. The use of different narrative tools facilitated a multifaceted and context-specific representation of training needs, both explicit and latent.

The document corpus was subjected to Qualitative-Thematic Content Analysis according to the model by Braun and Clarke (2006). In line with Narrative Inquiry (Clandinin & Connelly, 2000), the unit of analysis was identified as the narrative fragment or visual artefact possessing autonomous meaning. Coding followed a hybrid approach (Fereday & Muir-Cochrane, 2006): deductive, anchored to the areas of the DigCompEdu framework; inductive, aimed at capturing emotional experiences and processes of identity revision. Data saturation (Saunders et al., 2018) led to the identification of three interpretative macro-axes: the epistemological-methodological dimension, relating to application gaps and requests for methodological support; the reflective and transformative dimension, focused on processes of redefining professional identity in line with Transformative Learning (Mezirow, 2003); the relational and social dimension, oriented towards the analysis of collaborative dynamics and cultural resistance to innovation within Communities of Practice (Wenger, 1998).

The empirical materials, collected longitudinally throughout the entire training programme, constituted a heterogeneous narrative corpus divided into four main sources: reflective documentation by the trainers, comprising logbooks, critical notes and ethnographic notes on the dynamics that emerged during the

sessions; informal interprofessional exchanges, such as narrative conversations, debriefing video calls and immediate communications aimed at co-designing and monitoring the programme; narratives from course participants, collected in person and in digital environments, relating to teaching practices, methodological challenges and experiences of using the tools; artifacts and multimedia productions by the trainers, including digital works and interpretative memes (Di Donato, 2023), used to represent, in a visual and ironic manner, experiences and difficulties linked to the digital transition.To ensure greater reliability and reduce interpretative bias on the part of the researcher-trainers, a triangulation approach involving two blind analysts was applied (Lincoln & Guba, 1985). The independent coding of the corpus yielded an inter-rater agreement index (Cohen's K) of over 0.80. The empirical analysis highlights a marked polarisation of training needs: teachers demonstrate greater proficiency in areas relating to communication and the selection of digital resources (Area 1 and Area 2), whilst the main challenges emerge in Digital Assessment (Area 4) and Facilitating Student Skills (Area 6). The data reveal the difficulty in transforming the instrumental use of technologies into pedagogical practices geared towards advanced assessment and the critical co-creation of digital content (Figure 2).

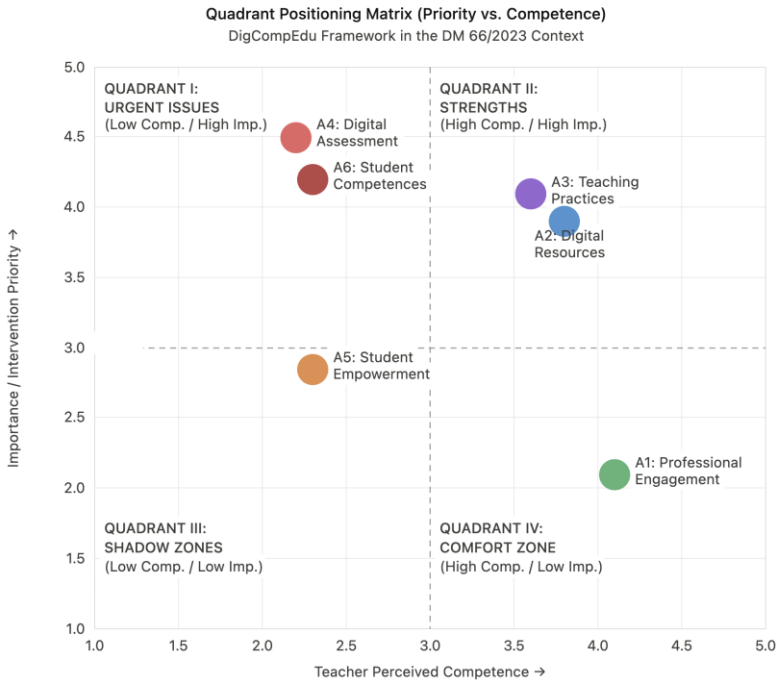


Fig. 2. Compiled by the authors

The intersection of self-perceived digital competence (X-axis) and the methodological and pedagogical importance attributed by teachers (Y-axis) provides a map of the main identity-related tensions and training needs that emerged from the analysis of the DigCompEdu framework (Figure 1). The positioning of the six macro-areas across the four quadrants highlights a marked polarisation of training needs.

Quadrant I – Urgent issues (low competence/high importance) concentrates the main professional weaknesses and the 'disorienting dilemmas' described by Mezirow (2003). Area 4 (Digital Assessment) has the lowest perceived competence level (X: 2.1) compared to the highest importance attributed (Y: 4.5), followed by Area 6 (Student Competences) (X: 2.2; Y: 4.2). Teachers' accounts and the trainers' ethnographic observations reveal a widespread difficulty in translating the technical use of technologies into advanced assessment and training practices, accompanied by requests for immediately applicable tools.

Quadrant II – Strengths (high competence/high importance) includes Area 3 (Teaching practices) (X: 3.5; Y: 4.1) and Area 2 (Digital resources) (X: 3.8; Y: 3.9). These dimensions represent teachers' operational 'comfort zone', linked to the daily use of digital tools for managing teaching. However, the proximity to Quadrant I suggests the need to transform these skills into practices geared towards assessment and the critical development of students' skills.

In Quadrant III – Grey Areas (low competence/low importance), Area 5 (Student Empowerment) (X: 2.3; Y: 2.8) emerges. The data indicate limited attention to digital inclusion and personalisation, often delegated to support teachers and rarely perceived as a shared responsibility of the entire class council.

Quadrant IV – Technical comfort zone (high competence/low importance) contains Area 1 (Professional engagement) (X: 4.2; Y: 2.1). The use of institutional tools and school digital channels now appears to be established as a standardised bureaucratic practice, perceived as a technical prerequisite rather than an area for professional development.
In the second phase of the research, the trainers' narrative accounts were interpreted as heuristic tools useful for investigating the meanings attributed to professional practice in different training contexts. The study engages with Transformative Learning, which assigns a central role to critical reflection in the revision of professional frameworks (Mezirow, 2003), and with Communities of Practice, which interpret teacher learning as a social process of participation and negotiation of meanings (Wenger, 1998).
The aim was to document how the training programmes under Ministerial Decree 66/2023 triggered processes of mutual reflection between trainees and trainers. The trainers shared experiences, methodological challenges, metaphors of learning and the outcomes of teaching experiments integrated with the DigCompEdu and DigComp 2.2 frameworks. These narratives prompted the trainers to engage in second-order reflections on professional identity, the effectiveness of the training proposals, and the dynamics of peer-to-peer dialogue. From this perspective, the trainers' narrative reflexivity is not merely a reporting of experience, but a generative practice of continuous professional learning.

4. Results: A Narrative SWOT Analysis

A SWOT analysis was used to systematise the resonances and negotiations of meaning that emerged from the trainers' narrative accounts. In line with the epistemological approach adopted, the matrix was not used as a quantitative classification tool, but as an interpretative device aimed at highlighting the situated nature of the trainers' professional experiences, the tensions surrounding identity, and the processes of transformative learning generated by interaction with the course participants.
The picture of training needs that emerged from the analysis — characterised by the critical issues in Areas 4 and 6 and the marginalisation attributed to Area 5 — triggered, through Narrative Inquiry (Clandinin & Connelly, 2000), a process of metacognitive reflection among the trainers, who were called upon to renegotiate the meaning of their professional stance in the face of the gaps and resistance that emerged in the training context. The findings of this monitoring and debriefing process have been summarised in the Narrative SWOT Matrix (Figure 3), which links internal factors — professional identity, skills and emotional aspects — with external factors, such as classroom dynamics and institutional pressures, highlighting their connection to teachers' training needs.

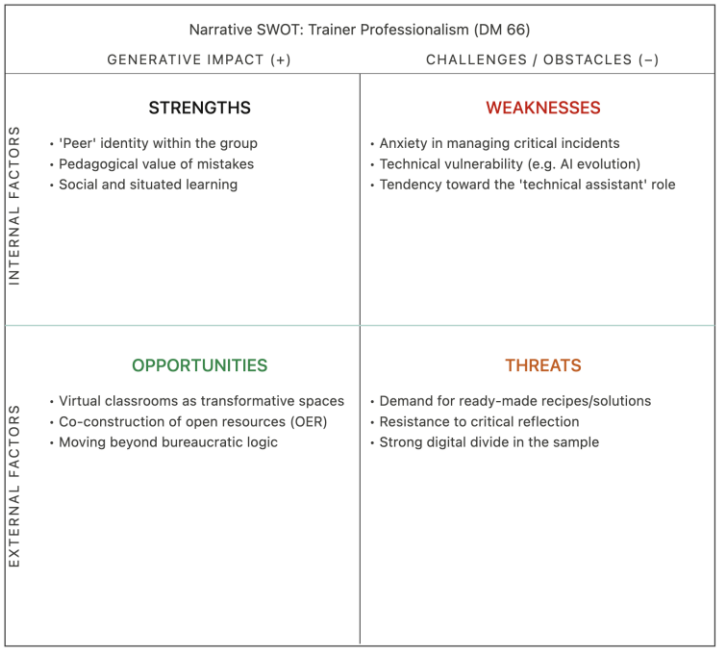


Fig. 3. Compiled by the authors

Generative convergence: strengths and opportunities - The trainers responded to the trainees' vulnerabilities by redefining their role from the perspective of the Community of Practice (Wenger, 1998). Rather than adopting a didactic stance, they emphasised the peer-to-peer dimension to acknowledge

and rework the teaching failures that emerged in the training contexts. Error was thus reinterpreted as an opportunity for social and situated learning. This professional stance was intertwined with the possibility of inhabiting virtual and physical classrooms as transformative spaces (Mezirow, 2003), in which the sharing of metaphors, diaries and artefacts helped overcome the purely bureaucratic logic linked to Ministerial Decree 66/2023, promoting the co-construction of open educational resources rooted in the concrete needs of schools.

Managing challenges: weaknesses and threats - The SWOT matrix also highlights the systemic and identity-related tensions faced by the trainers. The polarisation of the sample, divided between teachers with advanced needs (Areas 4 and 6) and teachers struggling with basic skills, highlighted the risk of a significant digital divide. This divide fuelled resistance to critical reflection and a widespread demand for immediate solutions, perceived as a response to technological performance anxiety. These dynamics have led to feelings of technical vulnerability among trainers and difficulties in managing critical incidents, exacerbated by the rapid evolution of tools such as generative Artificial Intelligence. Faced with requests for immediate operational support, there has sometimes been a tendency to slip into the role of 'technical assistant', with the risk of reducing the digital transition to mere IT training, thereby undermining pedagogical reflection on student assessment and empowerment.

5. Discussion: Narrative Reflexivity as a Practice of Continuous Professional Learning

The re-examination of documentary materials through SWOT Analysis highlights how the training activities within the DM 66/2023 pathways did not take the form of a simple transmission of content on the DigCompEdu framework, but rather a process of Transformative Learning. The sharing of instances of methodological failure and uncertainty in the use of digital tools acted as a 'disorienting dilemma' (Mezirow, 2003), fostering processes of critical reflection among both trainees and trainers. By acknowledging the vulnerabilities and difficulties that emerged in the narratives and professional exchanges, the trainers gradually redefined their own identity, shifting from a role as 'digital experts' to that of facilitators of reflective processes. The knowledge produced thus takes on a social and situated nature (Wenger, 1998), as professional learning is consolidated through shared engagement with error and with methodological and technological uncertainty.

However, critical issues remain. The demand for predominantly technical and instrumental support put forward by some teacher-trainees risks pushing the trainers towards an operational support role, reducing the space dedicated to pedagogical reflection and the co-construction of meaning.

Overall, the findings confirm that Narrative Inquiry is a generative practice for professional learning. The creation of narrative spaces dedicated to the experience of the digital transition makes it possible to address the most sensitive areas of the DigCompEdu framework — in particular digital assessment (Area 4) and the development of students' skills (Area 6) — whilst offering a replicable model for continuing professional development. From this perspective, the digital transition in schools goes beyond the technical compliance requirements linked to the PNRR and takes the form of a process of cultural and professional transformation for the entire school community.

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From Individual Innovation to Institutional Strategy: A Competency-Based Model for Strategic AI Integration in Faculty Development

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Abstract

The integration of generative artificial intelligence (AI) in higher education requires more than isolated initiatives; it demands a structured institutional model that connects pedagogical innovation, competency-based alignment, and academic validation. Within the framework of Universidad del Valle de Guatemala's Institutional AI Adoption Strategy, the Center for Excellence in Teaching and Learning led a collegial process to identify, analyze, validate, and systematize faculty practices in AI integration. The initiative aimed to strengthen student learning and ensure coherence with the university's educational model. It also supported faculty in integrating AI into their teaching strategies. The initiative was organized into four strategic phases. The first phase, Institutional Mapping of Teaching Practices, identified AI-integrated teaching and assessment practices across disciplines through a targeted faculty survey. A total of 135 practices were collected and organized according to the university's twelve generic competencies. The second phase, Selection and Alignment with Institutional Generic Competencies, involved a rigorous qualitative review and comparative analysis to determine the degree of alignment between reported practices and formal competency definitions. This process refined the initial set of practices and resulted in 25 selected practices with strong potential for institutional adoption. During the third phase, Interfaculty Collegial Validation, faculty from diverse academic departments participated in structured consultation sessions to evaluate clarity, relevance, and reproducibility. This collaborative dialogue strengthened the academic quality and cross-disciplinary viability of the selected practices. Finally, Academic Standardization and Institutional Projection led to the publication of an institutional document compiling validated practices, pedagogical guidelines, and structured levels of AI integration to support faculty development. This experience demonstrates that institutional AI adoption can be addressed through a structured, competency-aligned, and collegial model. It positions faculty as active agents of academic innovation and offers a replicable framework for higher education institutions seeking to integrate AI through a strategic and collaborative approach.

Keywords: *Faculty Development, AI integration, Higher Education*

1. Introduction

The rapid integration of generative artificial intelligence (AI) in higher education is reshaping teaching and learning practices across disciplines. While many faculty members are experimenting with AI tools to enhance their courses, these efforts often remain fragmented and disconnected from broader institutional strategies. As a result, universities face the challenge of moving beyond isolated innovations toward structured approaches that ensure pedagogical coherence, alignment with institutional goals, and sustainable faculty development.

In this context, the integration of AI in teaching cannot be reduced to the adoption of technological tools. It requires the design of institutional models that support faculty in developing pedagogically grounded practices, aligned with competency-based education frameworks and validated through collaborative academic processes. However, there is still a limited number of documented experiences that describe how institutions can systematically organize, evaluate, and scale such practices.

This experience addresses this gap through a structured, competency-based approach to AI integration in faculty development. The model is based on a collegial process that includes the identification, analysis, validation, and systematization of teaching practices, aligned with institutional generic competencies. Developed within the framework of the University of Valle de Guatemala's AI Adoption Strategy [1], the model offers a replicable approach for higher education institutions seeking to integrate AI in a strategic, collaborative, and pedagogically meaningful way.

2. Literature Review

2.1 Artificial Intelligence in Higher Education

The integration of artificial intelligence (AI) in higher education has expanded significantly in the last decade, positioning itself as a key driver of educational transformation. AI technologies—such as machine learning, learning analytics, and intelligent tutoring systems—enable personalized learning, adaptive feedback, and data-informed decision-making, contributing to more efficient and responsive teaching and learning processes [2] [3].
Research has shown that AI applications in education can be categorized into areas such as assessment, prediction, intelligent tutoring, and learning management, reflecting a broad spectrum of pedagogical uses [2]. These developments have the potential to reshape traditional instructional practices. They enhance access to information and transform how knowledge is constructed, delivered, and evaluated [4]. However, despite its transformative potential, the integration of AI in higher education is not without challenges. Issues related to ethical considerations, data privacy, infrastructure, and the lack of AI literacy among educators continue to limit its effective implementation [2][3]. Additionally, research highlights that while AI adoption is increasing, its pedagogical integration often lacks alignment with instructional design and institutional frameworks, which may reduce its impact on meaningful learning outcomes [4].

2.2 Faculty Development in the Context of AI

Faculty members play a critical role in the successful integration of AI in higher education, as they are key agents in designing, implementing, and mediating AI-enhanced learning experiences. However, current research indicates that faculty perspectives, competencies, and professional development needs in relation to AI remain underexplored [2]. Studies show that while educators recognize the benefits of AI—such as improved instructional efficiency, personalized teaching strategies, and enhanced feedback mechanisms—they also face significant challenges, including limited AI literacy, ethical concerns, and uncertainty about their evolving roles [2][5]. This tension reflects a broader gap between technological advancement and pedagogical readiness.
Moreover, the literature emphasizes that professional development is essential to support faculty in navigating this transformation. Effective faculty development programs should not only focus on technical skills but also address pedagogical integration, ethical considerations, and human–AI collaboration [2]. In this context, AI should be understood as a tool that supports teaching rather than replaces educators, reinforcing the need for structured institutional support systems.

2.3 Competency-Based Education and AI

Competency-based education (CBE) has gained increasing relevance in higher education as an approach that prioritizes the development of measurable skills, progressive mastery, and continuous improvement, rather than traditional time-based models of instruction. This approach emphasizes the alignment between learning outcomes, assessment practices, and the gradual development of competencies that can be transferred to academic and professional contexts [6]. Within this framework, the integration of artificial intelligence (AI) creates new opportunities to strengthen both the design and the monitoring of competency development.
AI tools enable more adaptive, data-informed approaches within competency-based education. They can support personalized learning pathways, automated assessment systems, and real-time tracking of competency development, allowing continuous monitoring of student progress, identification of learning gaps, and provision of targeted feedback. In the context of faculty development, AI has shown strong potential to support competency mapping, adaptive training processes, and micro-credentialing, although its large-scale adoption still faces challenges related to infrastructure, ethical considerations, and methodological limitations [6]. At the same time, recent advances in AI competency frameworks have expanded the understanding of what it means to be “competent” in AI-mediated educational environments. Beyond technical skills, AI competency is increasingly understood as a multidimensional construct that includes critical thinking, ethical awareness, digital agency, and self-regulated learning. International organizations such as UNESCO and the European Commission emphasize the importance of embedding these competencies into curricula, enabling students not only to use AI tools but also to engage with them in informed, reflective, and socially responsible ways [7].

However, despite these advances, existing competency frameworks are often based on conceptual definitions and self-reported measures, with limited attention to empirical evidence derived from real teaching and learning practices. Recent studies highlight a gap between theoretical models of AI literacy and the actual behaviors, strategies, and usage patterns that students develop in authentic educational contexts [7]. Similarly, research on AI in competency-based education shows that much of the literature focuses on student-centered applications, while the development of faculty competencies and related professional practices remains less explored [6].

This gap highlights the need to complement traditional competency-based approaches with practice-oriented and evidence-based perspectives. These perspectives better capture how AI is integrated into teaching and learning processes. Understanding competency development not simply as a predefined set of skills, but as a dynamic and context-dependent process shaped through interaction with AI tools, can provide a stronger foundation for designing faculty development models and institutional strategies [7]. In this sense, integrating AI into competency-based education requires not only technological adoption, but also pedagogical alignment and institutional support to ensure meaningful and sustainable implementation [6].

2.4 Toward Institutional Models for AI Integration

Recent literature increasingly highlights the need to move beyond isolated initiatives toward structured institutional approaches for the integration of artificial intelligence in higher education. While many universities have begun to develop guidelines, ethical frameworks, and support resources, these efforts are often fragmented or focused on specific aspects such as policy, tool usage, or academic integrity, rather than articulated as comprehensive and validated models for faculty development and pedagogical integration [2].

In the case of the University of Valle de Guatemala, significant progress has been made in establishing an institutional foundation for the ethical and responsible use of artificial intelligence. This process has been led by the Artificial Intelligence department through the institutional AI Adoption Strategy [1]. The strategy established dedicated working groups, including the Center for Excellence in Learning and Teaching (CEAD), responsible for AI integration in teaching. This is reflected in the development of formal guidelines for students and faculty members [8] [9], and a comprehensive Code of Ethics of UVG that emphasize principles such as transparency, equity, data protection, and respect for human dignity [10]. These institutional efforts promote the use of AI as a tool to enhance learning, foster critical thinking, and support responsible decision-making in academic contexts. However, despite this strong normative foundation, a gap remains between these institutional guidelines and their translation into everyday teaching practice. While the policies clearly define what responsible AI use should look like, they do not fully specify how these principles are operationalized in the design of courses, teaching strategies, and assessment practices. This creates a disconnect between institutional intent and pedagogical implementation, highlighting the need for more structured and practice-oriented models that support faculty in integrating AI in a consistent and meaningful way [4]. More broadly, this situation reflects a recurring challenge in higher education: institutional documents often provide a strong ethical and normative foundation, yet they do not always translate into structured, systematic, and empirically validated models that guide how AI should be integrated into teaching practice and faculty development processes. In many cases, the focus remains on defining principles and recommended practices, with less emphasis on how these are operationalized through coordinated processes, collaborative validation, and alignment with competency-based educational frameworks [2].

This reveals an important gap between institutional intention and pedagogical implementation. Although universities recognize the importance of integrating AI in a responsible and meaningful way, there is still a need for models that organize this integration into clear phases, incorporate faculty participation, ensure alignment with institutional competencies, and generate validated and transferable practices. Addressing this gap requires moving from guidelines and ethical frameworks toward structured institutional models that combine strategy, pedagogy, and collaborative processes. Such models should not only define what responsible AI use looks like, but also provide a systematic pathway for identifying, validating, and scaling effective teaching practices. In this context, the present study contributes by proposing an institutional model that articulates these elements through a phased, competency-based, and collegial approach to AI integration in faculty development.

3. Methodology

This work describes the systematization of an institutional experience aimed at integrating artificial intelligence (AI) into higher education teaching. The process was carried out at the University of del Valle de Guatemala and led by the Center for Excellence in Learning and Teaching (CEAD), as part of the institution's AI adoption strategy [1]. Its purpose was to identify, analyze, and strengthen teaching practices that incorporate AI into the teaching and learning process. Rather than applying a predefined model, this experience was developed through an iterative and collaborative process involving faculty members and academic teams. This approach enabled the identification of real practices implemented across different disciplines, their analysis in terms of their contribution to student learning, and their alignment with the institution's competency-based educational framework. To structure this process, a sequence of coordinated activities was implemented and organized into four sequential phases. These phases were designed to systematize the experience, ensure alignment with institutional learning objectives, and support its use as a reference for faculty development. The four phases are described below.

3.1 Phase 1: Institutional Mapping of Teaching Practices

The first phase focused on identifying existing teaching and assessment practices that incorporate artificial intelligence (AI) across different academic disciplines of the three UVG Campuses. To support this process, a structured survey was designed and distributed to faculty members who had previously demonstrated interest or experience in the use of AI in their teaching. The survey collected both contextual and descriptive information. Faculty members shared their perspectives on the use of AI in teaching, the perceived effectiveness of AI integration for developing institutional competencies [11], and descriptions of up to three teaching practices implemented in their courses.The identification of participants was informed by prior institutional initiatives and internal collaboration within the academic team. The information collected provided an initial mapping of AI use in teaching. It also captured practice-based examples grounded in real classroom experiences. The data collection process included follow-up communication to support participation and clarify responses when needed, establishing a comprehensive basis for the subsequent analysis and refinement phases.

3.2 Phase 2: Selection and Alignment with Institutional Generic Competencies

The second phase focused on the review, selection, and alignment of the teaching practices collected during the previous phase. Screened to identify those demonstrating an appropriate and ethical use of AI in accordance with the Institutional Guidelines for AI Use [8] [9] and the UVG Code of Ethics [10]. Practices that lacked sufficient information, showed limited pedagogical relevance, or did not provide evidence of meaningful AI integration were excluded at this stage. The remaining practices were then reviewed for clarity, level of detail, and alignment with the university's generic competencies. Faculty members whose practices met these criteria were invited to expand their submissions using a standardized format. The enriched practices were subsequently evaluated for pedagogical coherence, explicit competency alignment, and potential applicability across academic contexts. Practices that did not meet these requirements or lacked sufficient information after follow-up communication were excluded from the process, while those demonstrating consistency across all criteria advanced to the collegial validation phase. As part of this process, specifically, AI tools were used to support the organization and preliminary analysis of the practices by grouping similar practices, identifying recurring themes, and suggesting possible relationships between practices and institutional competencies. These outputs were used only as analytical aids and were not considered evidence for decision-making. All classifications, interpretations, inclusion or exclusion decisions, and competency alignments were reviewed and validated by the academic team. To reduce potential bias, AI-generated suggestions were systematically contrasted with the original faculty submissions and the formal definitions of the institutional competencies before any determination was made.

3.3 Phase 3: Interfaculty Collegial Validation

The third phase focused on the collegial validation of the teaching practices through structured consultation sessions involving faculty members from different academic departments from the three UVG Campuses. The purpose of this phase was to strengthen the clarity, relevance, and potential applicability of each practice through peer dialogue and collective reflection. To support this process,

three validation sessions were organized, in which selected practices were shared in advance with participants to allow for prior review and reflection. During the sessions, each practice was presented and discussed using a guided review process. Feedback focused on two guiding questions: (1) “Is there any aspect of this practice that should be clarified to improve understanding by other faculty members?” and (2) “Do you have any suggestions that could make this practice more effective, reproducible, or transferable?” Prior to each session, participants received the practices for review. During the validation sessions, faculty members presented their practices in concise three-minute presentations, followed by peer feedback and discussion. Participants were also invited to provide written comments or suggested revisions when necessary, that would include: observations, suggestions, and recommendations based on their disciplinary perspectives and teaching experience. Following the sessions, faculty members were given one week to incorporate the recommendations received and submit a revised version of their practice to the academic team responsible for the final publication. This phase emphasized collaborative engagement as a mechanism to refine the practices, ensuring that they were not only pedagogically sound but also understandable and transferable across different areas of knowledge.

3.4 Phase 4: Academic Standardization and institutional Documentation

The fourth phase focused on the academic standardization and institutional documentation of the teaching practices following the collegial validation process. The purpose of this phase was to organize the practices in a consistent and structured format, ensuring coherence in their presentation and facilitating their use as a reference for faculty development. To achieve this, a writing and coordination team synthesized the validated practices by applying a standardized structure that included key elements such as pedagogical purpose, description of activities, use of AI tools, and alignment with institutional competencies. This process involved organizing, editing, and refining the content to ensure clarity, consistency, and fidelity to the practices discussed during the validation phase. The documentation process was conceived as the development of the first volume of an institutional series aimed at compiling and disseminating AI-integrated teaching practices, establishing a foundation for future volumes that will continue to expand and update the collection as the institutional experience evolves.

4. Process Outcomes

4.1 Phase 1: Institutional Mapping of Teaching Practices

The first phase was implemented over a one-month period, beginning in the third week of August 2025 and concluding in the third week of September 2025. During this stage, a structured survey was distributed to 100 faculty members across the university’s six academic faculties, of which 60 responded. The survey collected both contextual and practice-based information, capturing faculty profiles, their level of experience using AI in teaching, and their perceptions regarding the effectiveness of AI integration for the development of institutional competencies. In addition, respondents described up to three teaching practices incorporating AI, resulting in a total of 135 reported practices.
From a quantitative perspective, the results show that the participating faculty are highly experienced educators, with 45% reporting more than 15 years of teaching experience and an additional 32% reporting between 5 and 15 years, indicating a strong institutional base of pedagogical expertise (Fig 1).

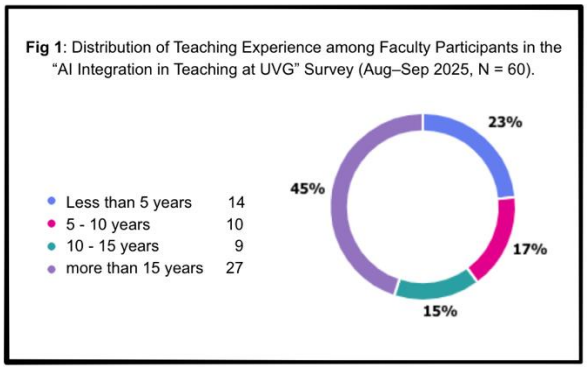


Fig 1: Distribution of Teaching Experience among Faculty Participants in the “AI Integration in Teaching at UVG” Survey (Aug–Sep 2025, N = 60).

In contrast, their experience with AI in teaching is relatively recent: nearly 70% of respondents reported having less than two years of experience integrating AI into their courses, with the majority indicating between six months and two years of use. Faculty responses also revealed current patterns of AI use in teaching. The data indicate that the integration of AI is primarily oriented toward supporting teaching and learning activities rather than being embedded as a fully structured pedagogical practice (Fig 2). Faculty reported varying levels of frequency in guiding students to use AI tools, suggesting that while its use is present in the classroom, it is not yet consistently incorporated across courses. These patterns reflect an exploratory stage of adoption. AI is primarily used as a support tool rather than as an integrated component of course design. Overall, these results indicate that the university is in an early stage of AI integration, characterized by high teaching expertise, emerging use of AI, and significant potential for institutional development.

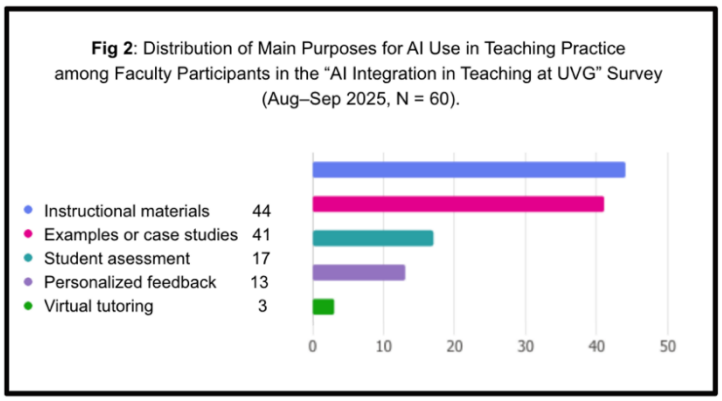


Fig 2: Distribution of Main Purposes for AI Use in Teaching Practice among Faculty Participants in the "AI Integration in Teaching at UVG" Survey (Aug–Sep 2025, N = 60).

4.2 Phase 2: Selection and Alignment with Institutional Generic Competencies

The second phase was conducted during October 2025 and focused on the refinement, selection, and further development of the teaching practices identified in the previous stage. An initial filtering process was applied to the 135 reported practices, resulting in the identification of 87 practices considered as good practices, concentrated among 40 faculty members, based on predefined criteria related to the appropriate and ethical use of AI. Following this selection, a standardized format was distributed to these 40 faculty members to expand and enrich the description of their practices, ensuring greater clarity, pedagogical detail, and alignment with institutional competencies. Each selected practice required the completion of this standardized form, which provided a more structured and comparable description of the teaching experience. As a result of this process, 25 practices were submitted in the required format. A subsequent review led to the approval of 18 practices, while five were excluded for not meeting the established criteria, and two were deferred to a second volume of the document due to time constraints faced by faculty members. This phase strengthened the quality, consistency, and alignment of the practices, preparing them for the collegial validation process.

4.3 Phase 3: Interfaculty Collegial Validation

The third phase was carried out during the first two weeks of November 2025 and focused on the interfaculty collegial validation of the selected teaching practices. During the first week, three structured validation sessions were conducted, in which a total of 18 practices approved in the previous phase were presented and discussed. In each session, six practices were evaluated by groups of 6 to 8 faculty members who had previously contributed good practices, fostering a peer-based review grounded in teaching experience. The sessions included the presentation of each practice followed by structured feedback focused on clarity, pedagogical coherence, and potential applicability in other academic contexts. As a result of this process, 17 practices were approved for continuation, while one practice was excluded from the process. During the second week, faculty members provided amendments and refinements to the practices based on the feedback received during the validation sessions, ensuring that each practice incorporated the necessary adjustments before moving to the final documentation phase.

4.4 Phase 4: Academic Standardization and Institutional Documentation

The fourth phase was carried out from mid-November to mid-December 2025 and focused on the academic standardization and institutional documentation of the validated teaching practices. During this stage, the team from the Center for Excellence in Learning and Teaching (CEAD) was responsible for organizing, editing, and refining the content to ensure clarity, consistency, and fidelity to the practices discussed during the validation phase. This process resulted in the development of the electronic publication "*Buenas prácticas de integración de la Inteligencia Artificial generativa en la docencia. Volume 1*" [12], a 128-page document designed to provide faculty with practical examples, guidance, and recommendations on how to effectively integrate AI into their teaching. The publication encourages faculty members to adapt these practices to their own academic initiatives. It emphasizes student learning and the development of competencies aligned with the university's educational model (Fig 3).
The document was distributed to the university's faculty during the second week of December 2025. In the first trimester of 2026, the practices included in the publication were further disseminated through institutional faculty development spaces organized by CEAD. These included "CafeCITo con", a forum aimed at sharing teaching practices and fostering reflection and collaboration among faculty across departments, where 4 practices have been presented, and the "UVG Faculty AI Club", a space designed to explore and experiment with AI tools in higher education, where four practices have been presented. These dissemination efforts contributed to extending the impact of the initiative beyond documentation, promoting ongoing dialogue and engagement around the integration of AI in teaching.

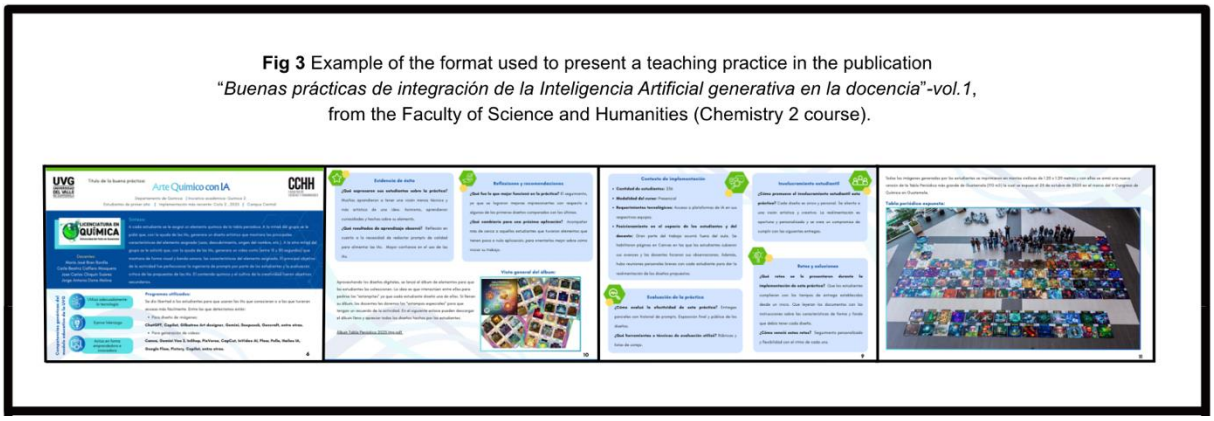


Fig 3 Example of the format used to present a teaching practice in the publication "*Buenas prácticas de integración de la Inteligencia Artificial generativa en la docencia*"-*vol.1*, from the Faculty of Science and Humanities (Chemistry 2 course).

5. Conclusions

The integration of artificial intelligence (AI) in higher education requires more than isolated faculty initiatives; it demands structured institutional processes that guide, support, and align teaching practices with educational goals. The experience documented in this study shows that a systematic and phased approach enables institutions to move from dispersed individual practices toward a coherent and organized framework for AI integration in teaching.
A key finding of this experience is the central role of faculty as agents of innovation. The identification, refinement, and validation of teaching practices showed that meaningful AI integration emerges from real classroom experiences. Collaborative processes help strengthen and refine these practices. The collegial validation phase, in particular, proved to be critical in improving the clarity, relevance, and transferability of the practices across disciplines.
The process also highlights the importance of aligning AI integration with a competency-based educational framework. By connecting teaching practices with institutional competencies, the initiative ensured that the use of AI contributes directly to student learning and the development of the graduate profile, rather than remaining at the level of technological adoption.
Finally, this experience confirms that documenting and systematizing teaching practices is a valuable strategy for institutional learning. The development of a structured institutional document not only supports faculty development but also creates a shared reference that promotes consistency, reflection, and continuous improvement in the integration of AI in teaching.

6. Implications for Faculty Development and Institutional Practice

The experience documented in this study suggests that higher education institutions seeking to integrate AI into teaching should move beyond policy frameworks and focus on structured, practice-based processes. A phased approach provides a clear pathway for organizing and scaling innovation. The process begins with identifying existing practices and continues through refinement, collegial validation, and institutional documentation. This approach can be adapted to different institutional contexts, allowing universities to build on their own faculty experiences rather than relying solely on external models.

For faculty development, the findings highlight the importance of creating spaces for collaboration and peer exchange. Structured validation processes, such as interfaculty consultation sessions, not only improve the quality of teaching practices but also promote shared understanding and collective learning among educators. These spaces foster reflection, encourage the exchange of ideas across disciplines, and support the development of a community of practice around AI integration.

The study also underscores the need to align AI integration with competency-based educational frameworks. Institutions should ensure that the use of AI tools is explicitly connected to the development of student competencies and learning outcomes. This alignment helps avoid superficial or purely instrumental uses of AI and instead positions it as a means to enhance critical thinking, problem-solving, and autonomous learning.

Finally, the results highlight the value of institutional documentation for sustaining and disseminating innovation. Structured resources that compile validated teaching practices provide shared references for faculty, support ongoing professional development, and encourage adaptation across academic contexts. In this sense, the process also contributes to strengthening the Scholarship of Teaching and Learning (SoTL) as a means to systematically document, share, and reflect on teaching practices within a community of educators committed to learning from and with one another. Therefore, documenting and sharing good practices becomes a key mechanism for continuous improvement and long-term institutional transformation.

While this experience provides a structured approach for identifying, validating, and documenting AI-integrated teaching practices, its primary contribution lies in the systematization of an institutional process and the development of faculty development resources. The initiative was not designed to measure the direct impact of these practices on student learning outcomes, faculty competencies, or long-term teaching quality. Future work may build on this foundation by examining the educational impact of the documented practices and their contribution to sustained pedagogical innovation.

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Educators' Experiences of Skills Development in a Funded Technology-Enhanced Learning Initiative: A Case Study of Three TVET Colleges

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Abstract

The rapid digitalisation of education systems has intensified the need for educators to acquire competencies in digital pedagogy and technology-enhanced learning (TEL). While global frameworks emphasise digital competence acquisition, less attention has been paid to how educators experience TEL training and the processes that enable or constrain meaningful skills development. This paper explores educators' perceptions of TEL training initiatives in three South African TVET colleges participating in the Pro-Telde Project, situating their experiences within broader debates on institutional readiness, pedagogical transformation, and sustainability of digital reforms. Drawing on an interpretive qualitative approach within a mixed-methods design, the study highlights anticipated gains in technical skills, pedagogical confidence, and contextual resource design, alongside constraints such as infrastructure limitations and uneven baseline digital literacy. Findings indicate that the training contributed to a shift from functional technology use towards learner-centred digital pedagogies, enhanced educators' confidence in creating and applying digital learning resources and promoted the transfer of skills through experiential and collaborative learning approaches. The study further found that the translation of newly acquired competencies into practice was strongly influenced by institutional conditions, including infrastructure availability, leadership support, and policy alignment. In addition, trained educators played an important role in extending digital capabilities to colleagues and students, thereby contributing to broader institutional capacity-building. The paper argues that effective capacity-building requires experiential learning, institutional alignment, and sustained post-training support, offering practical insights for higher education and TVET contexts.

Keywords: *Technology-Enhanced Learning (TEL), Digital Pedagogy, TVET Colleges, Skills Development, Institutional Readiness, Pro-Telde Project*

1. Introduction

The accelerating pace of global digital transformation has reshaped education systems, compelling institutions to integrate technology-enhanced learning (TEL) as a central pillar of teaching and learning. TEL is increasingly recognised as a mechanism to democratise access, foster learner engagement, and align curricula with the demands of knowledge economies [1]. Within technical and vocational education and training (TVET), the imperative is particularly acute: vocational institutions are expected to prepare graduates not only with technical expertise but also with digital fluency and transferable competencies that enable adaptability in volatile labour markets [2,3]. The growing importance of TEL lies in its capacity to transform learning environments into interactive, flexible, and student-centred spaces. Frameworks such as DigCompEdu [4] and pedagogical models like e-tivities [5] emphasise the role of digital tools in fostering active participation, collaboration, and contextualised knowledge construction. TEL can enhance student engagement, problem-solving, and workplace readiness when embedded within coherent pedagogical strategies [6,7]. Yet, despite these global advances, the translation of TEL into practice remains uneven, particularly in resource-constrained environments where infrastructural limitations and institutional fragmentation hinder sustainable adoption [8,9].

While TEL initiatives often emphasise technical skill acquisition, research highlights that meaningful integration requires pedagogical confidence, curriculum innovation, and the ability to design contextually relevant learning experiences [10.11]. However, educators frequently struggle to achieve this due to time pressures, uneven digital literacy, and limited institutional [12]. These challenges are particularly acute in South Africa's TVET colleges, which occupy a strategic role in addressing youth unemployment

and advancing social inclusion. Although policy frameworks envision TVET as a driver of local economic development governance and funding weaknesses have undermined institutional coherence and capacity [13] Consequently, studies reveal persistent curriculum-industry misalignment, limited digital learning infrastructure, and inadequate lecturer training, all of which prevent the sector from fulfilling its mandate [12,14].

The Pro-Telde Project was a funded initiative designed to strengthen educator capacity in digital pedagogy and TEL within South African TVET colleges. It has seven partners that are three from Europe (Pixel, Univerity of Sapienza Universita and University of Peloponnese) and four from South Africa (Univeristy of Jhannesburg, Vhembe TVET college, Majuba TVET college and Central Johannesburg TVET college). The project provided structured training programmes aimed at equipping South African lecturers with both technical skills and pedagogical confidence to integrate digital tools into their teaching practice. By foregrounding experiential learning, peer collaboration, and contextual resource design, Pro-Telde sought to address systemic challenges of institutional readiness and uneven digital literacy, positioning TEL as a sustainable pathway for curriculum innovation and improved teaching effectiveness in vocational education.

The purpose of this study is to examine how educators experience skills development within this initiative. Specifically, it asks: How do educators experience skills development in a funded technology-enhanced learning initiative within three South African TVET colleges? The following section reviews the literature relevant to this inquiry.

2. Review of Related Literature

2.1 Theoretical Framework

This study draws on Constructivism, Technological Pedagogical Content Knowledge (TRACK) and Technology-Enhanced Learning Perspectives to examine educator skills development across multiple dimensions; cognitive, pedagogical, and contextual, by drawing on Constructivism, Technological Pedagogical Content Knowledge (TPACK), and Technology-Enhanced Learning (TEL) perspectives. Originating from Shulman's concept of pedagogical content knowledge, TPACK extends the framework to include technology integration [10]. It emphasises the dynamic interplay between technology, pedagogy, and content knowledge, highlighting the need for educators to balance these domains in practice. Constructivist theory emphasises active, experiential learning, where learners construct knowledge through interaction with their environment [5]. In TEL contexts, constructivism highlights the importance of hands-on application, peer collaboration, and reflective practice.TEL perspectives emphasise the role of digital tools in enabling interactive, learner-centred environments [4,1]. They highlight the potential of TEL to democratise access, foster engagement, and align curricula with labour market demands. Together, TPACK, constructivism, and TEL perspectives provide a multidimensional lens for understanding educator skills development in the Pro-Telde Project. Collectively, these frameworks support the study's focus on educator experiences, institutional readiness, and the sustainability of TEL reforms in South African TVET colleges.

2.2 Technology-Enhanced Learning in TVET

TEL has been widely promoted as a transformative force in vocational education, enabling interactive, flexible, and learner-centred approaches. Studies highlight its potential to enhance engagement and achievement through gamification, smart classrooms, and digital tools [6,7]. However, adoption in TVET contexts remains uneven, with infrastructural constraints and limited institutional investment undermining sustainability [8].

2.3 Digital Pedagogy and Educator Competencies

Frameworks such as DigCompEdu [4] and TPACK [7] emphasise the integration of technological, pedagogical, and content knowledge. Yet research shows educators often struggle to move beyond technical proficiency to pedagogical innovation [11]. TEL training must therefore prioritise experiential learning and contextual resource design to build confidence and adaptability.

2.4 Skills Development and Professional Learning in TEL

Professional development initiatives have demonstrated that peer learning, reflective practice, and hands-on application are critical enablers of TEL competence [5]. In South Africa, however, lecturer training remains inadequate, with limited institutional support for sustained skills development [9]. The Pro-Telde Project's inclusion of lecturers alongside students reflects a multiplier logic which is the lecturers who acquire TEL competencies can extend programme benefits to colleagues and students who did not participate directly [15].

2.5 Institutional Readiness and Support Mechanisms

Institutional readiness is a decisive factor in TEL implementation. Leadership support, infrastructure provision, and policy alignment are essential enablers [3]. Yet South African TVET colleges face systemic fragmentation, with governance and funding models weakening institutional coherence [13]. The Pro-Telde Project highlighted these challenges across Majuba, Vhembe, and Central Johannesburg Colleges, where infrastructural limitations and uneven digital literacy shaped the effectiveness of training.

2.6 Challenges Affecting TEL Implementation

Constraints include infrastructure limitations, uneven baseline digital literacy, and time pressures [12]. These barriers hinder translation of training into practice, particularly in contexts where educators face heavy workloads and limited access to digital resources.

2.7 Knowledge Gap

Existing studies privilege quantitative measures of competence acquisition, neglecting qualitative insights into educators lived experiences. This study addresses that gap by foregrounding educators' perceptions of TEL training processes in the Pro-Telde Project, examining how institutional conditions enable or constrain skills development

3. Research Methodology

3.1 Research Paradigm and Approach

This study is situated within an interpretive qualitative paradigm, which prioritises understanding participants lived experiences and the meanings they attribute to their engagement with technology-enhanced learning (TEL). The interpretive stance is particularly appropriate for examining educators' perceptions of skills development, as it foregrounds subjective accounts of competence acquisition, institutional support, and pedagogical transformation rather than seeking generalisable causal claims [16]. To achieve this, the study adopts a qualitative approach embedded within a broader mixed-methods evaluation design. While quantitative measures of digital competence acquisition are common in TEL research [6,7], this study emphasises qualitative insights to capture the nuanced processes through which educators experience TEL training. Semi-structured interviews serve as the primary data source, enabling participants to articulate their perceptions of knowledge, skills, and competencies gained, as well as the enabling and constraining factors that shaped their development.

3.2 Research Design, Setting, and Procedures

A case study design was employed, focusing on three South African TVET colleges which are Majuba TVET College, Vhembe TVET College, and Central Johannesburg TVET College that participated in the Pro-Telde Project. These institutions represent diverse socio-economic and geographic contexts, ranging from rural to urban environments, thereby providing a rich basis for examining how institutional conditions shape educators' experiences of TEL training [12,13]. 12 participants were purposively selected to include educators directly engaged with the Pro-Telde initiative, ensuring relevance to the study objectives. Semi-structured interviews, lasting 30 minutes, were conducted online via teams, guided by open-ended questions on knowledge acquisition, pedagogical confidence, peer collaboration, and institutional support. Data were analysed thematically following [16] six-phase approach, combining inductive coding with deductive lenses informed by TPACK, constructivism, and TEL perspectives.

Trustworthiness was ensured through triangulation of perspectives, rich contextual description, and peer debriefing, while ethical clearance was obtained from the University of Johannesburg (Johannesburg Business School). Informed consent, confidentiality, and voluntary participation were strictly observed, with findings reported in a manner that avoided attributing specific constraints to individual participants or colleges.

4. Results

Five explanatory themes emerged from analysis of educator experiences across the Pro-Telde training cohort. Each theme follows the analytical sequence established by the programme documentation: intended objective, training content deployed to achieve it, participant baseline conditions, evidence of change, practical application, and implication. Table 1 provides a synoptic overview.

Table 1. Summary of Themes: Programme Objectives, Evidence of Change, and Implications

Theme	**Theme Title**	Programme Objective	Key Evidence of Change	Implication
4.1	From Functional to Pedagogical: The Reorientation of Digital Tool Use	Expand platform use from content delivery to interactive, learner-centred pedagogy (both courses)	Padlet deployed for live collaborative introductions; Google Forms converted to formal assessment; YouTube repositories created for on-demand student access; Flippity and Miro used to redesign content encounters	The programme succeeded by changing the pedagogical logic of tool use, not merely the tool inventory. Competence assessments measuring tool knowledge miss this shift entirely
4.2	From Individual Skill Acquisition to Institutional Capability Formation	Build multimedia content creation capacity through animation, motion design, and production tools (Nov course)	Animaker adopted for instructional animation; institution funded studio equipment across two budget cycles; studio became blueprint for colleagues; freemium access severed training capability from post-training practice	The studio ceased to represent an individual achievement and became institutional infrastructure through which capability could be continuously reproduced. Freemium access disrupts this cycle institutionally, not individually
4.3	Experiential Design and the Transfer Problem: What Made Learning Stick	Teach through TEL methods while teaching about them; embed active, task-based learning (both courses)	Physical-to-digital game bridging cited independently by multiple participants; deadline and peer presentation structures produced embodied confidence; prior Mahara exposure retrospectively organised through Miro instruction	The mechanism of transfer is pedagogical architecture: active before passive, embodied before digital, doing before describing. These are replicable design principles
4.4	Institutional Conditions and Three Modes of Capability Translation	Enable sustained TEL implementation beyond training completion (both courses)	Enabling environment: multi-year equipment budgets, sector-wide plan, trained educator as blueprint. Constraining environment: load-shedding, connectivity gaps, data costs redirected but did not extinguish practice. Policy-neutral environment: no governing framework, digital teaching individually driven and formally unrecognised	A third institutional condition beyond support and obstruction: policy neutrality. Capable educators in neutral environments cannot convert individual practice into institutional transformation
4.5	Capability Circulation Beyond Direct Programme Participants	Extend programme benefits through trained educators to colleagues and students (both courses)	Post-training peer gatherings extended skills to non-participants; cross-institutional networks persisted; online placement assessments replaced traditional student auditions; resistance to same-level peer training identified and addressed through leadership competence the programme had developed	Training effects did not remain with trained individuals. The relevant unit of evaluation is the institutional capability network, not the direct participant. Multiplier capacity includes change-management competence, not only content knowledge

Source: Authors own compilation

4.1 From Functional to Pedagogical: The Reorientation of Digital Tool Use

The first programme objective, addressed across both training blocks, was to expand educators' capacity to use digital platforms not for content delivery alone but for interactive, learner-centred pedagogy. The October 2024 course introduced visual data representation, PowerPoint, Canva, and Prezi for presentation design, alongside synchronous collaboration tools including Google Meet, Microsoft Teams, and Zoom. The November 2024 course deepened this by introducing multimedia resources, animation, and blended and online teaching methodologies. The two courses were designed to shift the function educators assigned to technology: from administrative infrastructure to a site of active student engagement. At the point of entry, participants across institutions described a pattern of digital use that was functional but pedagogically thin. The most common pre-training technology was the Learning Management System, used as a document repository rather than an interactive environment. Participants who had engaged with Google Classroom during COVID-19 described having done so reactively, without understanding the platform's full capacity. Others rated their prior digital engagement at two out of ten, describing pre-training use as limited to how to distribute lessons and materials. One participant, despite prior exposure to Google Forms, had not understood it as a formal assessment instrument until the programme made that application explicit. The pattern across the cohort was not absence of tools but absence of pedagogical purpose such as educators possessed platforms, they did not yet know how to use.
Following training exposure to Canva, Miro, Mentimeter, Flippity, Animaker, Padlet, Kahoot, and Wayground, educators described a fundamental reorientation in what they understood technology to be for. The most consequential shift was from transmission-oriented tool use to interaction-centred design. One participant redesigned first-day introductions by creating a Padlet profile, distributing the link through Google Classroom, having students complete their own introductions on the platform, and using the resulting visible collaboration as a live demonstration of digital interaction:

'*I'm using digital tools for introduction. And everybody could see that*.'

The activity did not add a tool; it reconstructed what a first class is for. Another participant moved Google Forms from casual use to formal assessment deployment. A third converted lesson content into Flippity sequences and Miro mind maps, replacing information presentation with designed interactive encounters. Participants who had used Teams or Zoom only during COVID-19 began recording lessons, uploading content to YouTube, and providing students with direct links:

'Whatever I recorded it, I uploaded in YouTube and I give the students a link. They're able to use that link, whatever they are, their own time, and they're able to repeat it.'

This is not a change of platform; it is a redesign of the temporal logic of teaching. The recording extends the lesson beyond the classroom and places control of repetition with the learner. The programme succeeded in this objective not by transferring new tools but by changing the pedagogical logic within which existing and new tools were deployed.

4.2 From Individual Skill Acquisition to Institutional Capability Formation

The November 2024 course aimed to build educators' capacity for multimedia content creation, with animation and motion design as its centrepiece. Animaker was the primary platform, introduced as an open production tool for creating animated instructional content. The course also addressed the quality of teaching materials, positioning production not merely as technical output but as pedagogically considered design. The intended outcome was an educator who could generate original instructional resources rather than deploy existing ones. Participants entered this dimension of the programme with uneven preparation. Those with prior digital exposure had conceptual frameworks that accelerated engagement with content creation. One participant described already knowing about timelines and content production but having lacked the structured conditions for application:

'I always wanted to know how to do animations because I sometimes I go to YouTube and Google how to. And search how to do it, but I never really got to do it because of discipline.'

The training did not introduce animation as a concept to this participant; it provided the facilitated conditions under which self-directed interest became applied capability. Participants entering with

limited prior digital experience encountered animation as genuinely novel, describing it as among the first things of its kind they had encountered. The same training content produced different entry mechanisms depending on what participants brought to it. Hands-on production emerged as the decisive mechanism of capability formation. Participants consistently identified application rather than instruction as what sharpened skill:

'When you listen, you sit there and listen, you are not participating. When you do, basically doing is being interactive with the content. So, when you interact with the content by doing something, an activity, that's when your skills are sharpened.'

The training cycled between explanation and application within the same session, and active production was the norm rather than the exception. Participants described remaining at computers through lunch to continue working, a pattern confirmed by the facilitators themselves, who observed that the South African cohort had not left their machines when the session was formally paused. The most consequential expression of this theme was not the content creation skills themselves, but what happened to them institutionally. Following training completion, one institution approved multi-year equipment budgets for studio infrastructure: microphones, interfaces, studio monitors, and a camera procured across two annual budget cycles. The participant who had established the studio described colleagues using it as a model:

'Everyone is looking at me now like, okay, let's see the blueprint. We're going to build from there.'

The studio ceased to represent an individual achievement and became institutional infrastructure through which capability could be continuously reproduced. This distinction carries theoretical weight: a studio is not a set of skills but an enabling environment for continuous production, not a threshold reached but a space maintained. Individual competence had generated institutional investment, and that investment had created the conditions under which further competence could be developed without additional external training. A constraint emerged that worked in the opposite direction. Several platforms introduced in the November course operated on freemium models, restricting functionality without institutional licensing. One participant observed:

'You are training, but you're not really training, because you need full access to get all the features of the tool.'

Where institutions did not extend budgets to licensing, the gap between what training had shown to be possible and what post-training resources permitted converted fluent capability into partial access. This is not an individual problem; it is an institutional policy gap that individual motivation cannot bridge.

4.3 Experiential Design and the Transfer Problem: What Made Learning Stick

The programme's pedagogical approach was not only to introduce tools but to teach through them. Both course blocks incorporated active, task-based learning, and the November block specifically foregrounded blended and online teaching methodology as content, meaning that participants were simultaneously learning to teach online and being taught through online methods. The intended effect was for educators to experience the learning approaches they were expected to implement, making the pedagogy of the training itself a demonstration of what it was advocating. Participants consistently identified the facilitators' design strategy as what distinguished Pro-Telde from prior professional development experiences. Earlier training, described as narrowly focused on single tools, had been largely reception-based: a programme delivered to an audience.
Pro-Telde was experienced as structurally different because learning was generated through activity. The facilitators' technique of beginning with traditional physical games before moving to their digital equivalents was cited independently by multiple participants as the most effective single approach. The bridge made the logic of digital interaction visible in embodied terms before asking participants to operate it through a screen:

'They interacted with us first, and then they said, okay, this is how you do this in a computer.'

This was not a motivational technique; it provided a conceptual structure for understanding what interaction means, which participants could subsequently apply when designing their own classes. One

participant described how the training allowed her to link prior knowledge she had accumulated without fully understanding. She had encountered a collaborative digital tool in a postgraduate diploma programme but had been told only that it was a mind map. The Pro-Telde training introduced Miro by name, with a full account of its pedagogical applications, and in doing so gave meaning to an experience she had already had. The training gave meaning to experiences participants had previously encountered but not fully understood. The physical and temporal structure of training also functioned as a confidence-building mechanism. Being given deadlines, preparing presentations for peer audiences, and writing reports on behalf of one's college created an accountability structure that replicated professional responsibility:

'a sense of accountability was also enforcing us that you need to be accountable to report.'

Confidence, in participant accounts, was not a feeling produced by reassurance, but a state produced by having delivered. One participant moved from describing himself as 'a low average' before training to doing whatever he did 'with confidentially and with motivated', locating that shift in the accumulated experience of completing, presenting, and submitting rather than in instruction. The mechanism of transfer was pedagogical architecture that is active before passive, embodied before digital, doing before describing.

4.4 Institutional Conditions and Three Modes of Capability Translation

The programme's objectives were addressed at the level of individual educator competence. The institutional conditions into which trained educators retained were not part of the programme design. Yet those conditions proved to be the primary determinant of whether competence became practice. Participants across institutions described moving between two structurally different environments which are the training environment that is characterised by reliable infrastructure, collaborative peers, facilitated support, and access to full platform functionality, and the institutional environment, which varied significantly in its capacity to sustain what training had produced. Three structurally distinct modes of institutional response emerged from the data. In institutionally enabling environments, capabilities became embedded within broader organisational systems. One institution responded to training completion by approving multi-year equipment budgets, developing a sector-wide TEL implementation plan, and positioning the trained educator as a model for colleagues. The institution was described as 'already ready for implementing' and as approving 'everything that we say we need'. Individual capability was drawn into institutional development which is what one person had learned became the blueprint for what the institution was building. Existing infrastructure further amplified this effect that computer laboratories meant digital tools were available for every lesson without additional provision, removing the access problem before it arose.

In institutionally constraining environments, capabilities remained dependent on adaptation and individual effort. Participants in rural settings described infrastructure conditions that redirected but did not extinguish TEL practice. Unreliable internet connectivity, load-shedding that suspended digital activity for days, inadequate laboratory provision relative to student numbers, and the cost of mobile data for students who lacked institutional connectivity all shaped what was possible:

'Because I'm from the rural areas, network coverage or internet connectivity, that is the biggest problem.'

Educators adapted by shifting to offline content, uploading recorded lessons to google classroom for asynchronous access, and redesigning assignments to account for uneven connectivity. Practice continued, but it was carried entirely by individual resourcefulness rather than institutional provision. In policy-neutral environments, capabilities remained individually held and structurally unsupported. One participant described an institution in which there was:

'No policy that speaks to online teaching'.

Digital practice was individually driven and formally unrecognised:

'Some of us were doing it because we know how to do it.'

There was no accountability for digital teaching, no resource allocation attached to it, and no shared institutional direction. Capability existed and was genuinely exercised which one participant taught through a month-long hospitalisation and produced more than twenty student distinctions during that period. But those results were the outcome of personal commitment rather than institutional design, and they could not be extended to colleagues, accounted for in institutional reporting, or built upon over time. Policy neutrality is structurally distinct from obstruction; it does not resist TEL practice, but it ensures that practice remains permanently individual.

4.5 Capability Circulation Beyond Direct Programme Participants

Training effects did not remain with the educators who had been directly trained. Across all four participants, capabilities circulated into institutional networks through multiple channels which are peer support gatherings, cross-institutional collaboration, redesigned institutional procedures, and the informal transmission of skills to colleagues who had not attended the programme. This pattern was not incidental; it was described as a normative expectation, partly enforced and partly driven by the confidence formation that training had produced. Post-training gatherings at the college level were used to review whether skills were being applied, help colleagues who had encountered difficulties with specific tools, and share knowledge with lecturers who had not attended. This knowledge-sharing was understood as self-reinforcing: 'The more you spread the information, you learn more.' The act of transmission required a different and deeper engagement with content than receiving it, and that deeper engagement consolidated the transmitter's own understanding. Capability circulation was therefore not merely charitable knowledge transfer; it was a productive mechanism for the educators doing the circulating.

Cross-institutional peer networks formed during training persisted after it. One participant described sustained collaboration with a colleague from Central Johannesburg College, extending to joint podcast production and ongoing creative exchange across institutional boundaries. Another described deliberately sitting with participants from other institutions during training sessions and finding that cross-institutional groups were sites of practical support in which colleagues with stronger digital skills demonstrated techniques to those still developing them. The training's rotation of venues across all three colleges and its inclusion of international training in Italy and Greece both contributed to this that they enforced institutional mixing and produced a shared professional identity that outlasted the formal programme.

The social dynamics of circulation were more demanding than simple sharing. One participant described the specific difficulty of training colleagues at the same institutional level:

'When you want to train your colleagues who are at the same level with you, it comes with resistance.'

Peer authority is negotiable in ways that hierarchical authority is not, and willingness to learn from a colleague can be conditioned by assumptions about relative standing. The programme had prepared participants for this, developing not just digital capability but the leadership and patience required to work with resistant colleagues:

'This project taught us to take the initiative, to be the leaders or to be the pioneers to make sure that those who don't want change, they don't resist to change easily.'

Capability circulation at the peer level depends on this social and institutional competence, not only on content knowledge. Circulation also took institutional procedural forms. One participant used online assessment tools, acquired through the programme, to replace the traditional audition process for incoming students, moving prospective students to online placement assessments that the system marked automatically. This was not an application of a tool to an existing process; it was a redesign of an institutional procedure using capability that training had produced. The programme had not specified this application; it emerged from the participant's engagement with their institutional context and the agency the training had produced. The impact boundary of the programme was therefore not defined by who attended it.

5. Discussion

Findings indicate that TEL interventions function less as direct skills transfer mechanisms and more as capability catalysts, whose effects depend on how institutional environments absorb, reproduce, and

circulate what participants acquire. Training exposure is necessary but insufficient; sustainable pedagogical change arises from the interaction between learning design quality, institutional conditions, and capability circulation networks. The most consequential achievement of Pro-Telde was not expanded tool knowledge but a shift in pedagogical logic: participants reoriented what they understood technology to be for. This gap between possessing a platform and knowing what to do with it corresponds precisely to the TPACK distinction between technological knowledge and technological-pedagogical knowledge [10,17]. Thus, evaluating training by which tools participants can name asks the wrong question; the right question is whether they can articulate how a tool changes the student–content relationship. While the literature frames TPACK integration as an individual cognitive achievement [10,11], the Majuba studio complicates this. Individual competence generated institutional investment, which produced infrastructure enabling continuous capability reproduction without further external intervention. The studio became institutional infrastructure, not just individual achievement. Conversely, the freemium access problem disrupts this cycle at the policy level, imposing a constraint that only institutional action can resolve.

The pedagogical mechanisms that made learning durable rather than fragile are replicable. Facilitators' bridging strategy—moving from physical game to digital equivalent, operationalises [18] experiential learning cycle within sessions rather than privileging reception. A less documented mechanism also emerged: training worked not by introducing novelty but by providing an interpretive framework that made existing experience intelligible, retrospectively organising prior knowledge participants had accumulated without fully understanding.

Existing institutional readiness frameworks distinguish supportive from unsupportive environments, treating readiness as binary [3,8]. The findings require a third category: policy-neutral environments, which neither obstruct nor actively enable. The result is permanently individual capability, competence that cannot be extended to colleagues, embedded in processes, or built upon over time. This differs structurally from obstruction (no visible resistance) and from support (no mechanism for converting individual practice into shared capacity). Policy neutrality is underspecified in TEL literature; its identification here enables more granular analysis than binary readiness frameworks permit.

Conventional evaluation defines programme impact at the direct participant level [8,9], but this unit of analysis systematically understates effects. Training produced nodes in institutional capability networks, with effects circulating far beyond the original cohort; redesigned student intake procedures, studio infrastructure, cross-institutional collaborations, and peer gatherings extending skills to non-participants. Capability circulation is the mechanism through which time-bounded training acquires potential for enduring impact. However, circulation depends on social and political competence to manage peer resistance, not only on technical content. Programmes neglecting this dimension produce educators who can do things but cannot extend what they can do to others. This study supports a relational model in which capability formation, institutional conditions, and circulation are simultaneous and mutually determining, not sequential. An educator with strong capability in a policy-neutral institution remains a practitioner; the same educator in an institutionally committed environment becomes infrastructure. The outcome of a training investment is determined as much by what institutions do after training ends as by what the training itself achieves.

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Modelling, Not Telling: Embedding 21st Century Skills in Teacher Education through an Educational Escape Room

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Abstract

Integrating 21st-century competences into higher education requires more than policy rhetoric or theoretical endorsement; it demands concrete pedagogical practices that model creativity, collaboration, problem-solving, and adaptive thinking for future teachers. Although teacher-education programmes emphasise the importance of innovative, student-centred approaches in schools, they may remain anchored in traditional, discipline-bound and lecture-based formats. This paper presents a cross-curricular learning initiative designed to disrupt such habitual structures by introducing second-year teacher-training students to an immersive educational escape room as the starting point for a full-day interdisciplinary learning experience. The escape room serves as an active, task-based learning environment in which students engage with authentic problem-solving scenarios under time pressure. This design requires them to mobilise a broad range of 21st-century skills, shifting classroom dynamics from passive knowledge reception to creative, collaborative, and communicative meaning-making. The experience demonstrates in practice what teacher-education programmes frequently advocate in theory: that future teachers must learn through the pedagogies they are expected to enact. The pedagogical framework draws inspiration from Howard Gardner's theory of Multiple Intelligences. Challenges are intentionally designed to activate linguistic, logical-mathematical, spatial, interpersonal, intrapersonal, bodily-kinaesthetic, and other forms of intelligence, enabling students to contribute in varied and meaningful ways. This diversity of entry point competencies is often overlooked in conventional academic tasks, though the escape room generates new collaborative constellations in which leadership and participation shifts. Through this design, the escape room becomes a learning environment where multiple forms of ability are recognised, valued, and mobilised both Gardner's insights and contemporary 21st-century competence frameworks. Findings indicate that immersive, game-based learning designs can serve as powerful catalysts for reimagining teaching and learning in teacher-education programmes. By embodying rather than merely discussing 21st-century competences, the escape room bridges the gap between theory and practice and provides a concrete model of innovative pedagogy for future teachers.

Keywords: *21st-century skills; teacher education; cross-curricular learning; educational escape room;*

1. Introduction

Integrating 21st-century competences into higher education involves more than policy rhetoric or theoretical endorsement; it requires pedagogical practices that actively model creativity, collaboration, problem solving, and adaptive thinking for future teachers. Within teacher education, however, a tension often emerges between what is emphasised in the curriculum and what is enacted and modelled in the higher education lecture halls and classrooms; in other words, the difference between knowledge and competence. While programmes may well promote the importance of innovative, student-centred approaches in schools, the formats through which these ideas are taught may remain rooted in traditional, discipline-bound and lecture-based practices. This tension raises a key question: how can teacher education move from teaching *about* 21st-century skills to actively *modelling* them for students? While many programmes rightly incorporate opportunities for students to engage with such competences, these activities are often isolated within specific subjects rather than forming part of a coherent pedagogical approach. However, if future teachers are expected to implement these approaches in their own classrooms, the process must begin within teacher education itself. Learning how to teach in more collaborative, creative, and adaptive ways requires that such approaches are not only discussed, but experienced.

The study described in this paper draws on experiential and sociocultural perspectives on learning, where knowledge is understood as emerging through concrete experience and interaction [1] [2]. In addition, game-based and multimodal approaches inform the design, particularly in relation to immersion, engagement, and the mobilisation of diverse competencies [3] [4]. These perspectives provide a framework for analysing how the escape room functions as a learning environment in teacher education. These perspectives are reflected in the design of the escape room itself. From an experiential

perspective, the activity can be understood as a structured movement through challenge, reflection, and resolution [1], while the collaborative nature of the tasks reflects a sociocultural understanding of knowledge construction through interaction [2].
In response to this challenge, the present study explores how a more holistic and interdisciplinary approach might be carried out as modelling rather than presenting. The context for this was the organisation of a cross-curricular theme day for second-year teacher training students at Nord University, centred on artificial intelligence as part of a broader 21st-century competence framework. As an entry point to this topic, the focus was deliberately shifted towards what might be termed “natural intelligence” - the collaborative, creative, and problem-solving capacities students themselves bring to the learning situation. This was operationalised through the design and implementation of an interdisciplinary educational escape room, in which students engaged in time-restricted, collaborative problem-solving tasks requiring communication, adaptability, and collective meaning-making.
Drawing on observations from the activity and student feedback, the paper examines how this design functioned as a learning environment for the enactment of 21st-century competences. Rather than positioning the escape room solely as an engaging or motivating activity, the analysis suggests that it can be understood as a form of embodied pedagogy, through which students experience the kinds of learning environments they are expected to create in their future classrooms. In doing so, the study contributes to ongoing discussions about how teacher education might more effectively bridge the gap between pedagogical theory and practice.

2. Pedagogical Design and Methodological Approach

The escape room was designed by colleagues Raymond Lillevik and Patrick Murphy and took place in the campus black box theatre, which was reconfigured to create an immersive learning environment. The activity centred on four distinct boxes, each secured with a padlock, which students were required to open by identifying clues distributed throughout the room. Each box represented a specific topic and contained tasks that later formed the basis for the subsequent workshop on artificial intelligence.
To unlock the boxes, students interpreted both overt and hidden clues in order to construct three-digit codes. The topics - ranging from John 3:16 (of Biblical reputation) to dead writers, reggae, and fantasy literature - were deliberately varied, creating a diverse and interdisciplinary set of challenges. The design required students to draw on different forms of knowledge and ways of thinking, while negotiating meaning collaboratively within their groups. A 60-minute time limit structured the activity, introducing a sense of urgency that shaped both the pace and the collaborative dynamics of the task. In this sense, the escape room functioned not only as a sequence of tasks, but as a situated and collaborative learning environment.
The study adopts a small-scale qualitative, practice-based approach to examining this teaching method. The study involved 26 second-year teacher education students enrolled in programmes for years 1–7 and 5–10, randomly organised into six groups. Data were generated through three primary sources: first, observational notes taken during the activity captured students’ engagement, interaction patterns, and problem-solving processes, with particular attention paid to moments of collaboration, frustration, and achievement. Second, student feedback was anonymously collected following the session, in the form of a questionnaire focusing on students’ experiences of the activity and its perceived relevance for their future teaching practice. And third, feedback through dialogue immediately following the escape room session and completing questionnaires.
The role of the researcher as both designer and facilitator position the study within a practitioner inquiry tradition. While this enables close insight into the learning process, it also requires awareness of potential bias. The analysis is therefore interpretive in nature, aiming to identify recurring patterns across observations and student responses rather than to produce generalisable findings. The data were analysed thematically, guided by the study’s focus on engagement, collaboration, and the enactment of 21st-century competences, and interpreted through the theoretical perspectives outlined in the paper. Ethical considerations were addressed by ensuring voluntary participation and anonymisation of student contributions.

3. Analysis and Discussion

The analysis that follows draws on observations and student feedback from the escape room activity. Students’ engagement began even before entering the room, increasing both attention and readiness to engage. As one student reflected, “I was curious from the start - it didn’t feel like a normal lesson at all.” This highlights how the framing of the activity itself contributed to heightened motivation and

engagement. Being informed in advance that the session would start with an escape room generated curiosity and anticipation, which carried into the learning situation. This expectation was further intensified by the physical staging of the experience, as students were led blindfolded into a black box theatre reconfigured as an unfamiliar and immersive environment. The transition from a familiar classroom to a multisensory and unpredictable space signalled that this would not be a conventional learning activity, increasing both attention and readiness to engage. These dynamics align with game-based learning perspectives, where immersion and novelty play a central role in sustaining engagement [3], as well as with the concept of flow coined by Csikszentmihalyi, where challenge and immersion generate deep involvement [5].



Fig. 1. Entering the escape room

The tasks themselves were deliberately challenging, and both individuals and groups experienced periods of frustration when encountering difficulties. However, these moments of struggle were closely linked to strong emotional responses upon success. When groups unlocked boxes and progressed in the activity, this was more often than not marked by spontaneous and audible celebrations. Such collective expressions of achievement contrast with traditional classroom settings, where success is typically individualised and less visibly embodied. From an experiential learning perspective, these moments of tension and resolution constitute powerful concrete experiences that can later be reflected upon and conceptualised [1]. The intensity of the experience suggests that emotionally charged learning situations play an important role in supporting deeper engagement and retention.

The imposed time constraint introduced a clear sense of urgency, which in turn necessitated collaboration and reinforced collective responsibility and shared focus. One student noted that “we had to rely on each other – none of us could solve it alone.” This illustrates how the task structure made collaboration a necessary condition for progress rather than an optional strategy. Students quickly recognised that tasks could not be solved individually and that effective communication was essential. This resulted in high levels of participation across groups, with students contributing in different ways depending on the demands of the task. Competitiveness between groups further intensified engagement, functioning as a motivational driver without undermining collaboration. Instead, it reinforced collective responsibility and shared focus. These dynamics reflect a sociocultural understanding of learning, in which knowledge is constructed through interaction and joint problem-solving [2]. The shifting roles within groups, where leadership changed in response to different challenges, can also be understood as participation within a community of practice, in which learning emerges through shared activity and evolving roles.[6]



Fig. 2. Immersed in collaborative, problem-based, and time-bound challenges.

A particularly striking aspect of the activity was the visibility of diverse competencies among students. Different participants demonstrated different strengths depending on the nature of the task, with some excelling in logical reasoning, others in spatial or practical problem-solving, and others in communication and coordination. The escape room promoted forms of competence that are not always recognised in traditional academic settings. As one student remarked, “people who usually don’t speak much were suddenly the ones solving things”. This illustrates how the activity redistributed participation and made diverse competencies visible. This resonates with Howard Gardner’s theory of multiple intelligences [7] and aligns with multimodal perspectives that view meaning-making as extending beyond purely linguistic forms [4]. At the same time, the activity challenged more static understandings of differentiation. Rather than positioning students along a fixed axis of ability, competence within the escape room was situational and task dependent. The teacher’s role as game master, providing targeted hints and guidance in response to immediate needs, illustrates a dynamic and responsive form of adapted learning. In this context, distinctions between “stronger” and “weaker” students became less pronounced, as successful problem-solving depended on the collective mobilisation of varied competencies.

The shared experience of challenge, frustration, and eventual success also had a clear impact on group dynamics. Completing the escape room within the allotted time contributed to a strong sense of collective achievement, which carried over into the subsequent workshop on artificial intelligence. Groups were more cohesive, communicative, and willing to collaborate, suggesting that the escape room functioned not only as a standalone activity but as a social and pedagogical foundation for further learning. From a transformative learning perspective, such experiences may influence not only immediate engagement but also students’ orientation towards subsequent learning activities and pedagogical approaches [8].



Fig. 3. Overcoming frustration was a real challenge

Taken together, these findings suggest that the escape room functioned not merely as an engaging activity, but as a form of embodied pedagogy, in which students experienced key principles of student-centred learning in practice. By immersing students in collaborative, problem-based, and time-bound challenges, the activity created a learning environment in which 21st-century competences were not discussed in abstract terms, but actively enacted. The findings highlight how such experiences make visible the complexities of collaboration, differentiation, and meaning making, while also challenging traditional assumptions about classroom roles and practices. In this sense, the escape room can be understood not simply as a teaching activity, but as a pedagogical model that demonstrates what student-centred learning looks like in practice.
For teacher education, this points to a clear implication: if future teachers are expected to design learning environments that foster creativity, collaboration, and adaptability, they must themselves meaningfully encounter such environments as learners. Bridging the gap between theory and practice therefore requires not only new content, but new forms of teaching through which these competences can be experienced, reflected upon, and taken into their future classrooms. This suggests that modelling pedagogy in teacher education is not simply an enhancement, but a necessary condition for developing pedagogical competence in contemporary classrooms.

Photos by Patrick Murphy. Students have granted permission for the to be used in this paper.

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Transformative Teacher Learning in Secondary Education: The Role of Erasmus+ in Shaping Future Practice

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Abstract

This paper explores how Erasmus+ mobility programmes contribute to teacher learning and future educational practice in secondary education. Drawing on mixed-method principles, the study investigates how international mobility experiences support professional development, pedagogical innovation, and intercultural understanding among teachers from Malta and Spain. The paper is based on findings collected through questionnaires and semi-structured interviews involving teachers who participated in Erasmus+ mobilities. Findings demonstrate that participation in Erasmus+ activities encouraged teachers to reflect critically on their classroom practice, strengthen collaboration with international colleagues, and experiment with more inclusive and student-centred teaching approaches. Participants also reported increased motivation, emotional awareness, communication skills, and confidence in responding to diverse classroom needs. However, workload pressures, limited resources, language barriers, and varying levels of institutional support influenced the sustainability of Erasmus+ outcomes within schools. The paper concludes that teacher learning extends beyond technical skill acquisition and includes changes in professional identity, reflective practice, emotional awareness, and intercultural competence. Internationally connected professional development opportunities therefore remain highly relevant in preparing educators for the challenges of contemporary education.

Keywords: *Teacher training and learning, international training, pedagogical innovation, Erasmus+*

1. Introduction

The Erasmus+ programme has become one of the most influential educational initiatives within the European Union, supporting collaboration, mobility, and professional learning across educational sectors. The growing complexity of contemporary classrooms has increased the importance of continuous teacher professional development.

Contemporary perspectives on teacher learning emphasise reflective practice, collaboration, emotional awareness, and intercultural understanding rather than simply the acquisition of technical teaching skills [1]. According to Darling-Hammond et al. [2], meaningful teacher development occurs when educators participate actively in collaborative and practice-based learning experiences connected directly to classroom realities.

International mobility experiences also contribute to the development of intercultural competence. Deardorff [3] defines intercultural competence as the ability to communicate effectively across cultural contexts through openness, adaptability, and respect.

This paper focuses on the experiences of secondary school teachers from Malta and Spain who participated in Erasmus+ mobility programmes.

2. Literature Review

Teacher professional development has become a major focus within educational policy and research due to changing classroom realities and increasing expectations placed upon educators. Effective professional learning supports teachers in strengthening pedagogical skills, improving classroom management, and responding more effectively to students' academic and emotional needs. Continuous learning is therefore viewed as essential for educators who wish to remain adaptable and responsive within contemporary educational environments.

Darling-Hammond et al. [2] explain that professional development is most effective when it is collaborative, reflective, sustained over time, and connected directly to classroom practice. Teachers benefit most from opportunities that encourage active participation and practical engagement rather than passive forms of training. Erasmus+ mobility programmes attempt to create these conditions by exposing teachers to different educational settings and encouraging international collaboration.

The Erasmus+ programme supports educational mobility across Europe through training courses, workshops, teaching assignments, and job-shadowing opportunities. Research indicates that participation in Erasmus+ programmes contributes positively to teacher confidence, motivation, and willingness to adopt innovative teaching strategies [3]. Teachers frequently report renewed enthusiasm for teaching and stronger openness toward collaborative and student-centred methodologies after participating in international mobility experiences.

Reflective practice is another important element associated with Erasmus+ participation. Schön [5] argues that professionals improve their effectiveness through reflection on their experiences and actions [4]. Erasmus+ experiences encourage teachers to compare educational systems, question assumptions, and critically evaluate their classroom approaches. Such reflection often leads to pedagogical experimentation, professional growth, and greater awareness of students' learning needs.

Intercultural competence also represents a major outcome associated with international mobility. Deardorff [3] defines intercultural competence as the ability to communicate effectively across cultural contexts through openness, adaptability, and respect. Through interaction with colleagues from different countries, teachers develop stronger communication skills, empathy, and cultural awareness. These competencies are increasingly important within multicultural classrooms across Europe.

Existing studies further suggest that Erasmus+ participation contributes to emotional and interpersonal development. Teachers frequently report becoming more open-minded, reflective, and aware of the emotional dimensions of teaching following international mobility experiences. Exposure to different educational contexts encourages educators to become more sensitive to inclusion, wellbeing, and diversity within their own classrooms.

Another important aspect linked to Erasmus+ participation is professional collaboration. Mobility experiences provide opportunities for teachers to exchange ideas, resources, and teaching strategies with international colleagues. Such collaboration often continues after mobility programmes end through online communication and educational partnerships. These professional relationships support ongoing learning and encourage teachers to remain engaged in professional development activities [6].

Despite these benefits, several challenges continue to affect Erasmus+ participation. Existing research highlights workload pressures, administrative demands, language barriers, and insufficient institutional support as factors that may reduce the long-term sustainability of mobility outcomes [7]. Teachers may struggle to implement innovative practices when schools lack resources or when professional responsibilities limit opportunities for experimentation.

The comparative dimension of Erasmus+ participation is particularly significant when exploring educational contexts such as Malta and Spain. Educational systems differ in organisational structure, policy implementation, school culture, and levels of institutional support. These contextual factors may influence how teachers perceive mobility experiences and apply newly acquired knowledge within their classrooms.

Overall, the literature demonstrates that Erasmus+ programmes can contribute positively to professional development, reflective practice, intercultural competence, and pedagogical innovation. However, the long-term impact of mobility experiences depends significantly on institutional conditions and support structures within schools.

Building on the theoretical perspectives discussed in the literature, the study is guided by the following research questions:

The study is structurally guided by the following two central research questions:

1. **Research Question 1 (RQ1):** *How do secondary school teachers from Malta and Spain perceive the effectiveness of Erasmus+ as a contributor to their professional development?*
2. **Research Question 2 (RQ2):** *What factors facilitate or hinder the contribution of Erasmus+ mobilities to teacher learning experiences?*

3. Methodology

This study adopted a mixed-methods approach to investigate how Erasmus+ mobility programmes contribute to teacher learning experiences among secondary school educators in Malta and Spain. Mixed-methods research combines quantitative and qualitative approaches to provide a broader and more comprehensive understanding of educational experiences.

Note on Data Source: The empirical data, frameworks, and findings presented in this paper were originally compiled, analysed, and presented as part of a broader master's thesis project exploring international teacher mobilities at the University of Malta (Barbara, 2026) [4].

Quantitative data was collected through online questionnaires distributed to teachers who had participated in Erasmus+ mobilities. The questionnaire included Likert-scale items and open-ended

questions related to professional development, pedagogical innovation, intercultural competence, emotional awareness, and institutional support. The online format allowed participants from both Malta and Spain to respond flexibly and anonymously.
Qualitative data was gathered through semi-structured interviews conducted with selected participants from both countries. The interviews explored teachers' reflections on mobility participation, classroom practice, collaboration, emotional development, and professional growth. Participants were encouraged to discuss both the positive and challenging aspects of their Erasmus+ experiences.
The comparative framework adopted in the study allowed similarities and differences between Maltese and Spanish teachers' experiences to be identified. Thematic analysis was used to analyse qualitative data, while descriptive statistics supported the interpretation of questionnaire responses. Combining both forms of data enabled the study to examine broader trends while also exploring individual experiences in greater depth. Ethical procedures were maintained throughout the research process. Participation was voluntary, confidentiality was protected, and informed consent was obtained from all participants before data collection began.

4. Findings and Discussion

The findings revealed that Erasmus+ mobility programmes contributed positively to teachers' professional and personal development. Participants from both Malta and Spain described mobility experiences as valuable opportunities for reflection, collaboration, intercultural learning, and pedagogical innovation.

4.1 Professional Growth and Pedagogical Innovation (Addressing RQ1)

One of the strongest themes emerging from the data related to professional growth. Teachers explained that Erasmus+ experiences exposed them to alternative teaching methodologies and encouraged them to reconsider their classroom practices. In line with Darling-Hammond et al.'s definition of meaningful development, participants reported introducing more collaborative, student-centred, and inclusive approaches after returning from mobility experiences, linking training directly to classroom realities.
Exposure to different educational systems also increased teachers' confidence in experimenting with innovative teaching strategies. Many participants described Erasmus+ experiences as professionally motivating, noting that mobility activities renewed their enthusiasm for teaching and encouraged greater engagement in continuous professional development. Several participants referred to Erasmus+ participation as transformative because it allowed them to step outside routine educational environments and observe alternative approaches to learning, classroom management, and assessment.
Teachers also highlighted how mobility experiences encouraged greater creativity within the classroom. Exposure to digital learning tools, collaborative projects, and innovative methodologies inspired educators to adapt their teaching strategies according to students' interests and learning needs. Some participants explained that they became more willing to experiment with active learning approaches after participating in international training activities. This active experimentation reflects the core tenets of reflective practice outlined by Schön, where professional growth is catalysed by critically evaluating actions and trying new strategies.

4.2 Intercultural Learning and Emotional Awareness (Addressing RQ1)

Intercultural learning emerged as another major outcome associated with Erasmus+ participation. Teachers reported increased awareness of cultural diversity and stronger communication skills following interaction with colleagues from different countries. This growth aligns directly with Deardorff's framework of intercultural competence, which values the development of openness, adaptability, and respect across cultural contexts. Participants explained that intercultural experiences improved empathy, openness, and sensitivity toward students from diverse backgrounds.
Teachers also described becoming more adaptable and reflective within multicultural classroom settings. Exposure to different educational cultures encouraged participants to reconsider assumptions about teaching and learning while becoming more aware of alternative educational perspectives.
Another recurring theme involved emotional awareness and wellbeing. Several participants explained that Erasmus+ experiences encouraged greater reflection on the emotional dimensions of teaching. Teachers reported stronger awareness of student wellbeing, classroom relationships, and the importance of creating supportive learning environments. Some participants described becoming more patient and emotionally responsive following mobility experiences. Furthermore, interacting with

international colleagues and successfully participating in collaborative activities strengthened their sense of professional identity and belonging within a wider European educational community.

4.3 Professional Collaboration and Networking (Addressing RQ1 & RQ2)

Professional collaboration and networking represented additional important outcomes that act as both a product of growth (RQ1) and a facilitating factor for long-term sustainability (RQ2). Teachers valued opportunities to exchange ideas, resources, and teaching strategies with international colleagues. Many participants continued communication with educators they met during mobility activities through online collaboration and educational partnerships.

These professional relationships contributed to ongoing learning beyond the duration of the mobility itself. Teachers explained that collaboration with international colleagues encouraged them to remain engaged in reflective practice and continuous professional development.

However, the comparative dimension of the study also revealed that the success of this collaboration was heavily conditional on context. Teachers working within supportive school environments were far more likely to share mobility experiences with colleagues and implement innovative practices collaboratively, identifying school culture as a primary facilitating factor.

4.4 Challenges and Barriers: Factors Hindering Outcomes (Addressing RQ2)

Despite the positive outcomes associated with Erasmus+ participation, participants identified several structural barriers limiting the long-term impact and sustainability of mobility experiences. Workload pressures and administrative demands represented some of the most common challenges. Teachers often struggled to balance mobility participation and the implementation of new ideas with existing professional responsibilities.

Institutional support significantly influenced how teachers experienced Erasmus+ outcomes. Participants who received encouragement from school leadership were generally more successful in applying innovative practices after mobility participation. In contrast, teachers who experienced limited support reported greater difficulty integrating new methodologies into their schools. This directly confirms the literature warning that missing institutional support structures diminish the long-term viability of international training.

Resource limitations also hindered the execution of mobility outcomes in some schools. Participants explained that insufficient technological infrastructure and limited financial support restricted opportunities to sustain projects inspired by Erasmus+ participation.

Language barriers were also identified as challenges by some teachers, particularly during collaborative activities conducted in English or other foreign languages. Although many participants viewed these experiences as opportunities for improvement, some initially experienced difficulties participating confidently in discussions and collaborative tasks.

Ultimately, while Erasmus+ mobility programmes contribute positively to teacher development, reflective practice, intercultural competence, emotional awareness, and pedagogical innovation, the sustainability of these benefits depends significantly on fixing these institutional barriers within schools.

5. A Proactive Look at the Future

This paper examined how Erasmus+ mobility programmes contribute to the professional learning experiences of secondary school teachers in Malta and Spain. The findings demonstrate that international mobility supports professional growth, reflective practice, intercultural competence, emotional awareness, and pedagogical innovation. Teachers participating in Erasmus+ programmes reported increased motivation, stronger collaboration with international colleagues, and greater openness toward innovative and inclusive teaching approaches. Mobility experiences also contributed to communication skills, confidence, and reflective professional practice.

At the same time, the study highlighted several barriers affecting the sustainability of Erasmus+ outcomes, including workload pressures, limited institutional support, resource constraints, and language difficulties. These findings suggest that the effectiveness of mobility programmes depends not only on participation itself but also on the broader educational environment within schools.

As a conclusion, this study underscores that shaping the future of educational practice requires moving away from stagnant training models. Internationally connected professional development opportunities offer a transformative roadmap for the future, equipping educators with the dynamic intercultural and emotional competencies needed to navigate the unpredictable landscape of tomorrow's classrooms. To

realize a more informed future, stronger institutional support, deliberate structural resources, and continued international collaboration must be prioritized to solidify the long-term impact of Erasmus+ mobility experiences within secondary schools.

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