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Innovative paths to education: the effect of digital media on agricultural training in Austria

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ABSTRACT

This study delves into the evolving field of adult education, particularly examining the integration of digital media into agricultural training programs in Austria. The study is set against the backdrop of a broader digital transformation that is reshaping educational landscapes globally. It emphasises the importance of adapting adult education methodologies to include both e-learning and traditional face-to-face interactions to better accommodate the diverse needs and preferences of learners. The research specifically targets Austrian farmers, distinguishing between part-time and full-time farmers to explore differences in educational preferences. The study employs quantitative methods, including surveys and data analysis, to determine how factors such as age and media competence influence farmers' choices between digital and traditional learning formats. Notably, the document highlights a significant trend: younger farmers show a greater inclination towards digital platforms, whereas older farmers prefer conventional learning environments. Furthermore, the study investigates the role of media competence in shaping educational preferences, suggesting that enhanced digital skills are crucial for engaging effectively with modern e-learning tools. This is particularly relevant in promoting sustainable agricultural practices, where up-to-date information and techniques are essential. The findings aim to inform the development of tailored educational programs that not only meet the specific needs of farmers but also contribute to the broader goals of sustainable agriculture. By enhancing the alignment between educational content and learner preferences, the study advocates for a more effective and inclusive adult education system.

1. Introduction

Adult education is undergoing significant transformation, driven by the pervasive influence of digitalisation (Tippelt & von Hippel, 2018). In Austria, it represents the largest and most dynamic field of education, encompassing a wide range of theories, practices, and disciplines that address the teaching and learning processes involving adults (Gruber, 2013). This evolution reflects broader societal trends where lifelong learning has gained increasing value. However, a discrepancy remains between the societal appreciation for continuing education and the participation rates of adults (Tippelt & von Hippel, 2018). The advent of the pandemic further accelerated these dynamics, compelling adult education providers to adopt virtual learning environments to ensure continuity (Seufert & Meier, 2017). E-learning, as defined by Seufert and Meier (2017), refers to teaching and learning arrangements that utilise telecommunication services or electronic media. E-learning has become

a critical component of modern education, offering flexibility and accessibility (Tippelt & von Hippel, 2018). However, its successful adoption depends not only on the availability of technological infrastructure but also on addressing the diverse needs and preferences of learners, which remain underexplored in agricultural education (Nachhaltige Tierhaltung Österreich, 2022).

In the domain of agricultural education, where practical applicability is paramount, providers endeavour to deliver targeted, contemporary programmes that enhance professional success and the sustainability of farming enterprises in Austria (Nachhaltige Tierhaltung Österreich, 2022). Despite this focus, extant studies on agricultural training and continuing education are sparse, with the majority of research concentrated on the school sector rather than adult education (ibid). In the context of agricultural training, studies are often limited to periodic reports, such as those conducted by the University of Agricultural and Environmental Education every five to six years, leaving

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significant gaps in the availability of comparable and current data (*Nachhaltige Tierhaltung Österreich*, 2022). Addressing these gaps requires more regular and systematic data collection efforts, as well as the integration of international benchmarks and perspectives to create a robust comparative framework.

The increasing relevance of digitalisation, coupled with improved access to technology and the need for enhanced media competencies, highlights the potential of e-learning to complement conventional face-to-face methodologies. However, challenges such as varying levels of media competence, limited representativeness in existing data, and the lack of longitudinal insights into the long-term impact of digital learning on agricultural education further underline the need for targeted research. The present study aims to address these gaps by investigating how farmers engage with educational formats in the context of e-learning and face-to-face events, with a focus on the influence of demographic factors such as age, employment status, and media competence. The findings of the study aim to contribute to the wider literature on adult education by providing evidence-based recommendations for designing more effective and inclusive training programmes, while highlighting the importance of continuous evaluation and methodological advancements in agricultural education.

2. Theoretical background and literature review

In this integrated section, the theoretical underpinnings are discussed alongside a review of pertinent literature, thereby establishing a comprehensive framework that links learning methodologies and digital competencies with the educational needs and preferences of farmers. This approach not only highlights the theoretical concepts but also aligns them directly with empirical evidence from the literature, creating a coherent narrative that supports the objectives of our study.

In the contemporary knowledge society, the significance of lifelong learning and continuous professional development is progressively acknowledged. Adult education is confronted with the challenge of devising effective and flexible learning methodologies to cater to the diverse requirements of learners. E-learning, encompassing synchronous and asynchronous methods in addition to blended learning, has emerged as a fundamental component of this educational landscape (*Erpenbeck et al.*, 2015). The present study focuses on the educational preferences and media competencies of farmers, with a view to better understanding their engagement with different learning formats. This study is situated within a broader discourse on digital transformation, as evidenced by policy frameworks such as DigComp 2.2 AT, which aligns the development of digital competencies with national and European agendas (*Bundesministerium für Digitalisierung und Wirtschaft*, 2021).

2.1. Forms of education and training

Digitalisation has had a profound impact on adult education, rendering e-learning an indispensable tool. *Arnold (2013)* and *Kerres (2016)* describe e-learning as encompassing a variety of electronic media, virtual spaces, and blended learning arrangements, complemented by traditional, non-electronic elements. This transition towards digital media and virtual learning spaces has been facilitated by the internet and advanced learning management systems (*Zawacki-Richter*, 2017). The pivotal function of e-learning in ensuring uninterrupted educational continuity during crises was accentuated by the advent of the pandemic. In response, governments worldwide have implemented policies aimed at facilitating the digital transformation of higher education, allocating resources such as infrastructure, funding, and training to support the adaptation to these challenges (*Abbas et al.*, 2024).

E-learning environments provide entirely digital alternatives to traditional face-to-face education by facilitating content delivery, communication, collaboration, and administrative functions. However, the rapid shift to online learning also highlighted challenges such as

technostress – defined as the strain caused by adapting to new digital tools and technologies in a short period – which significantly impacted academic performance and engagement (*Abbas et al.*, 2023). The extant literature demonstrates that effective educational environments require thoughtful design, encompassing authentic tasks and social interaction opportunities to foster contextual understanding and independent learning (*Middendorf*, 2022).

Blended learning, a hybrid model combining in-person and digital components, offers versatile approaches to accommodate diverse learner preferences (*University of Alberta Centre for Teaching and Learning*, 2016). This method bridges the gap between traditional and digital education and is especially relevant in understanding the interplay between learners' preferences and their media competence (*Wannemacher et al.*, 2016). Hybrid models, such as HyFlex + Tec, have demonstrated potential in establishing resilient educational systems (*Abbas et al.*, 2024), though they may also intensify technostress if inadequately implemented (*Abbas et al.*, 2023). These findings support calls for integrated digital-pedagogical approaches rather than viewing digital and general teaching competencies as separate (*Alberti et al.*, 2022).

Synchronous learning facilitates real-time interaction via video conferencing or live chats, while asynchronous learning supports self-paced engagement through forums or email (*IATE Interactive Terminology for Europe*, 2022; *Aschemann & Russ-Baumann*, 2023). During the pandemic, both formats were found to be of crucial importance, yet they also revealed inequalities, such as limited infrastructure and insufficient digital literacy among learners (*Abbas et al.*, 2024). Prolonged isolation and the absence of direct social interaction in asynchronous settings have the potential to exacerbate technostress (*Abbas et al.*, 2023).

Conversely, traditional face-to-face learning, which typically involves physical co-presence, remains relevant, especially for practical and socially interactive elements of education (*Abbas et al.*, 2023). Nevertheless, it is increasingly the subject of criticism for its failure to incorporate virtual presence. Consequently, the concept of presence in adult education should be refined to encompass location-based and virtual interactions (*Aschemann & Russ-Baumann*, 2023). Hybrid arrangements have also been introduced, but these have proven challenging, particularly when learners need to rapidly adjust to shifting modalities (*Abbas et al.*, 2023). Consequently, the efficacy of educational formats, particularly within rural and agricultural contexts, is contingent not solely on technological accessibility but also on the calibre of pedagogical design and the support of policy frameworks (*Abbas et al.*, 2024; *Rummler et al.*, 2021).

In the domain of agricultural adult education, research findings underscore the pronounced predilection of farmers for experiential learning methodologies, collaborative teaching practices, and engagement in on-farm demonstrations and applied research endeavours. The establishment of relationships with colleagues and trusted advisors is pivotal to the effective transfer of knowledge. Individualised support, personal communication, and context-specific learning opportunities are particularly valued. Educational interventions that align with these preferences, such as farmer-led workshops, farm visits, and focus groups, are more likely to foster trust and engagement (*Franz et al.*, 2010). These findings imply that the design of e-learning offerings for farmers must consider the technological medium and replicate or complement experiential and peer-driven elements to be effective.

2.2. Media competence

Media competence, defined as the ability to effectively use, critically evaluate, and communicate through various media, is a key factor influencing engagement with digital learning. As a core competence, it enables learners to make informed choices and to use the internet with confidence. Media competence is emphasised in national and international policy documents as being essential for the information society

(Bundesministerium für Bildung, Wissenschaft und Forschung, 2018). The DigComp 2.2 AT framework provides an evaluative structure for media competence at both the individual and institutional levels, thereby helping to align educational practices with European standards (Bundesministerium für Digitalisierung und Wirtschaft, 2021).

During the pandemic, deficits in media competence among learners and educators alike were identified as significant barriers to effective online and hybrid learning, thereby reinforcing the necessity for institutional support, training programmes, and the establishment of inclusive digital infrastructures (Abbas et al., 2024). In their conceptual model, Huda and Hashim (2022) stress the dual importance of professional and ethical dimensions in media education to foster both individual and societal well-being. It is also noteworthy that media competence serves a mitigating function in relation to technostress: learners who possess higher digital skills experience fewer negative effects when transitioning to or engaging with hybrid learning environments (Abbas et al., 2023). Consequently, cultivating media competence is identified not only as a pedagogical goal but also as a prerequisite for sustainable, inclusive, and resilient educational systems.

In rural learning contexts, particularly among farmers, media competence must also be linked to trust in the source, contextual relevance of the content, and the ability to integrate information into practice. While many farmers now regularly use the internet for learning, contrary to earlier findings, this usage is often accompanied by the need for clear, understandable, and locally adapted content (Franz et al., 2010). Farmers derive the greatest benefit from digital learning tools when these tools complement personalised advice and facilitate connection to real-world applications.

2.3. Knowledge channels

This study explores the heterogeneity in farmers' preferences for acquiring knowledge and participating in training. Prior to the pandemic, Austrian research demonstrated a pronounced predilection for conventional information channels such as printed trade journals, with digital formats playing a negligible role (Kirmer et al., 2019, 2020). However, the digitalisation of educational offerings in the wake of the global pandemic has significantly diversified these channels. Platforms such as social media, brief video content, and specialised online portals have gained prominence.

Policy-makers have recognised the necessity of expanding these knowledge channels, particularly in rural areas where access to digital infrastructure may still be limited (Abbas et al., 2024). Consequently, the effective design of educational programmes in agricultural contexts must be holistic, integrating digital and pedagogical competencies alongside socio-technical considerations (Abbas et al., 2024; Morris & Rohs, 2021). Hybrid learning models have been identified as a potential solution to this problem, as they are able to accommodate different preferences and contexts, while also addressing challenges related to digital inequality and technostress (Abbas et al., 2023).

Concurrently, the extant literature highlights the persistent significance of informal, experience-based, and community-driven knowledge networks among farmers. Farmer-to-farmer interactions, personal narratives, and trust-based relationships remain pivotal to the access and validation of agricultural knowledge. Peer networks, books, and manuals are particularly important for alternative and organic farmers, while female farmers often assume leadership roles and encourage male participation in educational programmes (Franz et al., 2010). In this context, agricultural advisors are expected to play a pivotal role in facilitating networked learning, acting as connectors between practitioners, researchers, and institutions. Programmes that reflect this shift, by embedding advisory services into peer-driven, participatory, and localised learning systems, are better positioned to meet the evolving expectations and needs of farmers.

3. Current study – aim and hypotheses

The aim of this study is to address a gap in the extant literature on learning in agriculture by exploring farmers' preferences for education and training formats (e-learning versus face-to-face) and their preferred knowledge channels. Specifically, the study examines how these preferences are influenced by farmers' media competence and demographic factors such as employment status and age. By integrating these variables, the research contributes to a deeper understanding of how agricultural training can be tailored to diverse learner needs in an increasingly digitalised educational landscape. Utilising a combination of hypothesis testing and a mixed-methods approach, this study offers insights grounded in empirical evidence, which serve as a foundation for the refinement of educational programmes and the enhancement of their relevance and accessibility for agricultural professionals. According to Morris and Rohs (2021), it is important to investigate the potential dangers of self-directed learning when learners do not have sufficient media competence. They recommend further studies to confirm that media competence is a prerequisite for competent self-directed learning in the information age.

The increasing significance of flexibility in adult education underscores the necessity for adaptable learning formats, a benefit that online learning formats can provide to part-time farmers, who are able to better balance professional and personal commitments (Middendorf, 2022). Conversely, full-time farmers tend to favour face-to-face training due to its emphasis on direct interaction and practical applications. On the basis of this theoretical foundation, the following hypothesis can be derived: Part-time farmers are more likely to favour online settings than full-time farmers (H1).

Older learners often feel more comfortable with traditional learning methods, as these align better with their past learning experiences. Additionally, face-to-face learning provides social interaction and contextual understanding, which are particularly important for older farmers (Schuknecht & Schleicher, 2020). Despite the advancement in digital content quality, it is plausible that older farmers will continue to favour face-to-face formats. This prompts the formulation of the following hypothesis: Older farmers prefer face-to-face training compared to younger farmers, despite the high-quality online offerings (H2).

Participants with higher levels of media competence possess greater skills and confidence in using digital platforms, which increases their interest in online training (Bundesministerium für Bildung, Wissenschaft und Forschung, 2018; Huda & Hashim, 2022). Conversely, lower levels of media competence may act as a barrier, reducing interest in such formats. Based on this relationship, the following hypothesis can be derived: Interest in online training is linked to the media skills of participants (H3).

Studies demonstrate that older participants frequently exhibit inferior media skills in comparison to younger generations. This phenomenon can be attributed to the fact that younger individuals have been raised in a digitalised world, where digital tools play a pivotal role in education and employment (Bundesministerium für Digitalisierung und Wirtschaft, 2021; Morris & Rohs, 2021). Consequently, the following hypothesis can be formulated: Older participants have lower media skills than younger participants (H4).

In order to better understand farmers' preferences for training formats and their relationship with demographic and skill-based factors, this study developed a conceptual framework (see Fig. 1) highlighting three key dimensions: employment status, age differences and media competence. It is hypothesised that part-time farmers will prefer online training because of its flexibility, while full-time farmers may prefer face-to-face formats that fit their schedules (H1). Generational preferences are explored through age differences, with older farmers likely to prefer face-to-face learning for its familiarity, while younger farmers may be more open to online formats (H2, H4). Media competence is crucial in shaping training preferences; higher media competence is

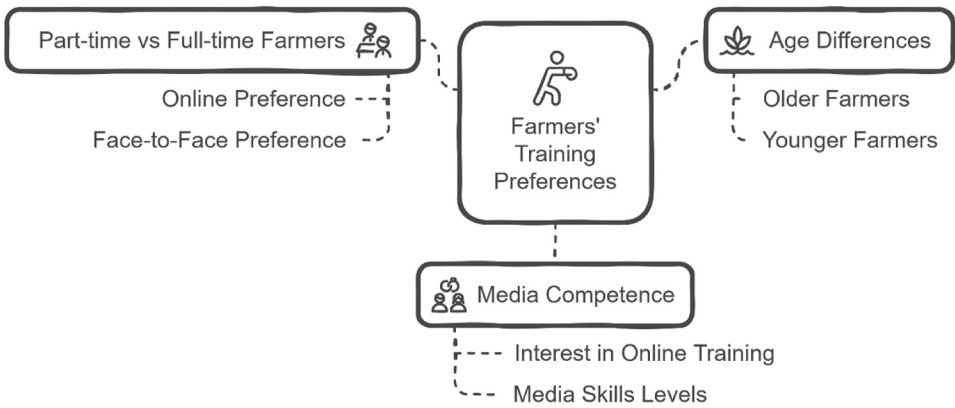


Fig. 1. Graphical representation of the content to be examined.

Forms education and training	Knowledge channels	Media competence
Synchronised online settings	Advice from veterinarians	Data processing
Face-to-face events	Advice from Austrian Chamber of Agriculture	Communication, co-operation
Asynchronous online settings	Advice from associations	Content creation
Blended Learning	Advice from other organisations	Security
	Private consultants	Problem solving
	Exchange experiences with other farmers	
	Specialist lectures	
	Trade journals printed	
	Educational brochures from the association	
	Field inspection, practical days	
	Excursions	
	Further training courses	
	Internet platforms, forums	
	Trade journals available digitally	
	Short information videos	
	Online training courses	
	Social Media, WhatsApp	

Fig. 2. Data collection factors.

expected to correlate with greater interest in online learning, while lower media competence, often among older farmers, may limit digital engagement (H3, H4). This framework links the study's hypotheses to the interplay of demographic and technological factors and provides a basis for effective, targeted training strategies in agricultural education in Austria.

4. Methodology

The methodological approach consists of a quantitative survey

analysing digital learning scenarios, knowledge channels and self-assessment of media competence in the context of lifelong learning specifically for the field of sustainable animal husbandry in Austria. Farmers participated in the survey and assessed the effectiveness and preference of the mentioned factors. The survey, based on a standardised questionnaire, provides a comprehensive overview of the requirements and views on the training formats. Recommendations for training programmes can be derived from the results.

4.1. Participants

With the help of the Educational institutes event database, it was possible to filter out the training participants in the period from January 1, 2019 to December 31, 2022. The basic population for the survey consists of 4510 participants in continuing education. All of these participants attended at least one training event in the above period. However, if these participants took part in an event more than once, they were only included in the survey once. With a population of 4510 people, a confidence level of 95 % and a margin of error of 5 %, this results in a minimum sample size of 355 participants. A total of 624 participants took part in the survey, of whom 251 were female (40.2 %) and 373 male (59.8 %). The age ranged from 17 to 75 years with an average of 42.8 years. For further analysis and calculations, three age groups were formed: younger (up to 35 years), middle-aged (36–49 years) and older (50 years and over). 303 participants (48.6 %) stated that they ran their farm as their main occupation, 458 participants (41.3 %) indicated that they ran a part-time farm. 63 participants (10.1 %) had no business. Participation in the survey was optional. Those who did not wish to disclose their information did not take part. Furthermore, no data was collected that would allow specific conclusions to be drawn about individual persons. The results are therefore completely anonymised and do not allow the identification of individual persons.

4.2. Instrument and data collection

A comprehensive questionnaire with factors (Fig. 2) relating to digital competence, knowledge channels and training formats was created and forms the basis for the revision of the existing training programmes with a focus on online formats. Personalised emails were sent to training participants for distribution. Data was collected using fully standardised questionnaires. The survey was conducted in two stages. First, the questionnaire was pre-tested. Specifically, six farmers were included in the pre-test. The feedback was in terms of concrete definitions and comprehensibility, which were incorporated before the questionnaire was released to all participants. In the second step, the data were then collected with the specific sample according to scientific criteria (Döring & Bortz, 2016). The survey period was limited to 6 July to July 16, 2023. The questionnaire was created and published using

SurveyMonkey. All Likert scales used in the survey had 5 levels. A Likert scale with 5 levels is a frequently used measuring instrument in empirical social research to record attitudes and opinions. It enables a differentiated recording of opinions, is easy for respondents to understand and offers a neutral response option with the middle category. The five-point scale also allows statistical evaluations in which the answers can be treated as interval-scaled data, even if this is methodologically debated.

After data collection the data cleansing of the SPSS dataset was carried out systematically. First, a thorough check was carried out for missing values, whereby a distinction was made between system-defined and user-defined missing values. Using frequency analyses and box plots, the value ranges of all variables were checked for plausibility and possible outliers. Subsequently, the coding was standardized, which particularly affected the Likert scales and the recoding of negatively formulated items. When dealing with missing values, a decision was made according to defined criteria as to whether these could be supplemented by logical imputation or whether affected cases had to be excluded from the analysis. The consistency check included checking the consistency of answers to similar questions and checking the correct filtering. All data cleansing steps were documented in a syntax file to ensure traceability. The cleansed data matrix forms the basis for further statistical analyses.

4.3. Data analysis

Quantitative data analysis involves the statistical analysis of numerical data to test hypotheses. For this purpose, inferential statistics were used, which allow conclusions to be drawn about relationships in the population from sample data. For three hypotheses (H1, H2 and H4) the Kruskal-Wallis test was used.

The Kruskal-Wallis test is a non-parametric statistical method used to compare more than two independent groups. It is often used as a non-parametric alternative to the one-factorial analysis of variance (ANOVA). The test is based on rankings, whereby all values of the compared groups are brought into a common ranking. In the present study, the Kruskal-Wallis test was chosen for several reasons: Firstly, the Likert scales used have an ordinal level of measurement, which necessitates the use of a non-parametric procedure. Secondly, the data collected cannot be assumed to be normally distributed, which speaks against the use of parametric methods such as ANOVA. Thirdly, the test allows the simultaneous comparison of several independent groups, which was necessary for the investigation of the various subgroups in the sample. The test checks the null hypothesis that all compared groups come from the same population, i.e. that there are no significant differences between the mean ranks of the groups.

The Pearson correlation coefficient (r) is a standardized measure of the strength and direction of the linear relationship between two interval-scaled variables and was used for hypothesis H3. It can assume values between -1 and +1, with +1 indicating a perfectly positive and -1 a perfectly negative linear relationship. A value of 0 means that there is no linear relationship between the variables. The use of the Pearson correlation coefficient in the present study is based on several methodological considerations: Firstly, it enables the precise quantification of the strength of correlations between the variables under investigation. Secondly, the interval scaling of the data collected and the assumption of a linear relationship between the variables allow the use of this parametric method. The standardized form of the coefficient also enables the direct comparison of different correlations regardless of the original units of measurement of the variables.

The reliability of the system was determined by calculating the internal consistency using the Cronbach's alpha coefficient. Reliability coefficients exceeding 0.90 are typically regarded as excellent, while those surpassing 0.80 are deemed to be high (Döring & Bortz, 2016). The reliability analysis conducted for the domain of media competence yielded a Cronbach's alpha coefficient of 0.87, indicative of substantial

measurement accuracy.

5. Results

5.1. Kruskal-Wallis-Test for forms in education and training

H1. Part-time farmers are more likely to favour online settings than full-time farmers.

To test this hypothesis with the Kruskal-Wallis-Test, the preference for synchronous online settings and face-to-face events was used depending on the participants' mode of operation. The variable MV Operational Management refers to the type of main professional income. There are three categories: Main occupation, Secondary occupation and No holding. The n column indicates the number of people in each category. The mean rank column indicates the mean rank of the preference scores for each category. The significance column indicates the p-value of the Kruskal-Wallis test.

The Kruskal-Wallis-Test for H1 in Table 1 shows a significant difference in preference for synchronous online settings and face-to-face events depending on the type of farm management of the participants.

In synchronous online settings, participants have a lower mean score (MV = 1.8) than those who prefer face-to-face training (MV = 2.1). The Kruskal-Wallis test for synchronous online settings shows in the mean scores that those participants who run the business as a secondary occupation significantly (p = 0.020) prefer these settings more than those who do not run a business or run it as their main occupation. The situation is different for face-to-face events. Participants without a holding prefer this type of event significantly (p = 0.015) more than farmers with a main or secondary occupation. The Kruskal-Wallis test for all variables shows that there are no significant differences with regard to the form of farm management in online settings. Hypothesis H1 is therefore rejected. It could not be confirmed that part-time farmers prefer online settings more than full-time farmers.

5.2. Kruskal-Wallis-Test for knowledge channels

H2. Older farmers prefer face-to-face training compared to younger farmers, despite the high-quality online offerings.

To test this hypothesis, the knowledge channel variables were used, which enable a social interaction. Seven different sources of information were examined: exchange experiences with other farmers, advice from other organisations, private consultants, excursions, training courses, Facebook and Instagram. Table 2 shows the mean rank of preference ratings for each information source for the three age groups (up to 35 years, 36–49 years and 50 years and older). The Significance column indicates the p-value of the Kruskal-Wallis test. The Kruskal-Wallis test in Table 2 for hypothesis H2 shows no preference for online offerings in the preferred knowledge channel for younger participants (up to 35 years) and no preference for face-to-face events for older participants

Table 1
Kruskal-Wallis-test for H1.

Variable	MV	Operational management	n	Middle rank	Significance
Synchronised online settings	1.8	main occupation	301	323.77	0.020*
		secondary occupation	257	289.60	
		No holding	63	337.29	
Face-to-face events	2.1	main occupation	298	298.15	0.015*
		secondary occupation	257	331.49	
		No holding	63	273.47	

* p < 0.05 significant | **p < 0.01 high significant | 1 = I prefer very much; 5 = I don't prefer.

Table 2
Kruskal-Wallis-test for H2.

Variable	MV	Age	n	Middle rank	Significance
Exchange experiences with other farmers	1.6	Up to 35	172	284.15	0.005**
		36 to 49	260	307.79	
		50 and older	188	338.35	
Advice from other organisations	2.7	Up to 35	172	293.03	0.022*
		36 to 49	257	297.37	
		50 and older	186	336.53	
Private consultants	2.8	Up to 35	171	264.73	0.000**
		36 to 49	157	312.44	
		50 and older	188	342.93	
Excursions	2.4	Up to 35	172	279.42	0.024*
		36 to 49	259	320.65	
		50 and older	188	323.30	
Further training courses	2.4	Up to 35	172	280.90	0.006**
		36 to 49	255	302.67	
		50 and older	186	337.07	
Facebook	3.7	Up to 35	172	237.74	0.000**
		36 to 49	255	323.11	
		50 and older	189	353.19	
Instagram	3.8	Up to 35	172	232.74	0.000**
		36 to 49	255	324.27	
		50 and older	189	356.17	

*p < 0.05 significant | **p < 0.01 high significant | 1 = I prefer very much; 5 = I don't prefer.

(50 years and older).

Participants aged up to 35 years prefer significantly more the exchange of experience with other farmers ($p = 0.005^{**}$), advice from other organisations ($p = 0.022^{*}$), private advisors ($p = 0.000^{**}$), excursions ($p = 0.024^{*}$), further training courses ($p = 0.006^{**}$) and the social media Facebook ($p = 0.000^{**}$) and Instagram ($p = 0.000^{**}$). The analysis shows that online training is desired by all participants regardless of age and that there are no significant differences. The analysis shows that younger participants (up to 35 years of age) prefer direct advice and face-to-face events. Hypothesis H2 is therefore rejected. It could not be confirmed that older farmers prefer face-to-face training compared to younger farmers, despite the high quality of online training.

5.3. Pearson correlation for media competence and online training

H3. Interest in online training is linked to the media skills of participants.

To test this hypothesis the factors Online Training and Media Competence were correlated. The Pearson correlation shows that there is a significant positive correlation ($r = 0.314$, $p = 0.000^{**}$) between course participants' media skills and their interest in online training, as shown in Table 3.

Hypothesis H3, that interest in online training is related to media competence, is therefore confirmed. This means that people with higher

Table 3
Correlation coefficient Pearson for H3.

		Media competence
Online training	Correlation coefficient	0.314
	Significance	0.000**

*p < 0.05 significant | **p < 0.01 high significant | 1 = I prefer very much; 5 = I don't prefer.

levels of media competence tend to be more interested in online training.

5.4. Kruskal-Wallis-Test for media competence

H4. Older participants have lower media skills than younger participants.

This test was used to investigate whether there are significant differences in the assessment of five digital skills between farmers of different age groups. The digital skills examined are: Data processing, communication and cooperation, problem solving, security and content creation. The table shows the mean rank of the ratings for each competence for the three age groups (up to 35 years, 36–49 years and 50 years and older). The Significance column indicates the p-value of the Kruskal-Wallis test.

The Kruskal-Wallis test for media competence in Table 4 shows significant differences in the self-assessment of digital competence according to the age of the respondent.

The mean value (MV) indicate how high the self-assessment of digital skills is in the different age groups. The results of the Kruskal-Wallis tests show high significance values ($p < 0.01$), indicating that the self-assessment of digital skills varies statistically significantly between the age groups. With regard to data processing, it can be seen that for all five variables, younger participants (up to the age of 35) rate their skills higher than participants in the other two age groups. For example, the younger respondents rated themselves as more competent in data processing ($p = 0.000^{**}$), communication, cooperation ($p = 0.000^{**}$), problem solving ($p = 0.001^{**}$), security ($p = 0.000^{**}$) and content creation ($p = 0.000^{**}$). Overall, the test shows significant differences between older and younger participants in terms of their media competence. Hypothesis H4 can therefore be regarded as confirmed. Older participants have lower media competence than younger participants.

6. Discussion

6.1. Forms in education and training

The findings of this study highlight the complex interplay between participants' preferences for learning formats and their demographic

Table 4
Kruskal-Wallis-test for H4.

Variable	MV	Age	n	Middle rank	Significance
Data processing	2.1	Up to 35	172	275.93	0.000**
		36 to 49	262	295.72	
		50 and older	190	368.73	
Communication, co-operation	2.4	Up to 35	172	239.06	0.000**
		36 to 49	262	309.03	
		50 and older	190	383.77	
Problem solving	2.5	Up to 35	172	281.09	0.001**
		36 to 49	262	305.44	
		50 and older	190	350.68	
Security	2.6	Up to 35	172	269.42	0.000**
		36 to 49	262	296.38	
		50 and older	190	373.73	
Content creation	3.0	Up to 35	172	254.58	0.000**
		36 to 49	262	308.41	
		50 and older	190	370.57	

*p < 0.05 significant | **p < 0.01 high significant | 1 = I prefer very much; 5 = I don't prefer.

characteristics. Referring to [Kirner et al. \(2019\)](#), online settings such as sharing experiences with farmers, advice from veterinarians, and expert lectures were identified as the most preferred formats. However, structured online training courses and webinars ranked lower, emphasising the need for targeted digital learning designs. This finding is consistent with [Seufert and Meier's \(2017\)](#) assertion that the integration of digital media must be meticulously tailored to the target audience and learning objectives.

Hypothesis 1, which proposed that part-time farmers would exhibit a greater propensity to favour online settings in comparison to full-time farmers, was refuted by the results. These results indicated that there were no statistically significant differences in overall online preferences between part-time and full-time farmers. However, part-time farmers demonstrated a stronger inclination towards synchronous online formats. This finding contradicts the theoretical assumption that part-time farmers would generally favour online formats due to their flexibility ([Middendorf, 2022](#)). The results suggest that the appeal of synchronous formats may lie in their ability to facilitate real-time interaction while accommodating professional commitments.

Regarding Hypothesis 1, contrary to initial assumptions, no significant differences were observed between part-time and full-time farmers concerning online preferences, although part-time farmers demonstrated a stronger inclination toward synchronous online formats. These findings suggest the implementation of expanded online offerings with diverse formats and app-based solutions to enhance accessibility. Particular emphasis should be placed on fostering media competence through detailed platform utilization guidance.

Furthermore, recent findings emphasise the increasing utilization of digital tools by farmers for knowledge exchange and advice, particularly within practice-oriented communities. Such tools encompass social media, online forums and messaging services. Twitter, for instance, is favoured for its feedback culture, practical peer-exchange, and the ability to overcome geographic boundaries ([Rust et al., 2022](#); [Skaalsveen et al., 2020](#)). Furthermore, WhatsApp groups have been identified as playing a significant role in facilitating connections among farmers who share similar practices, as evidenced by the case study of no-till farmers in England ([Skaalsveen et al., 2020](#)). Furthermore, digital tools are employed to access codified knowledge via governmental websites, particularly for subsidy applications and procedural information. However, the intricacies of bureaucratic processes frequently necessitate personal consultation with experts, underscoring that digital information access does not entirely eliminate the requirement for human advisory services ([Sutherland et al., 2017](#)). This finding corroborates the conclusion that, despite the facilitative role of digital platforms in knowledge exchange, first-hand observation of innovations within farming communities and trusted personal networks remains a more determinative factor for behavioural change ([Rust et al., 2022](#); [Skaalsveen et al., 2020](#); [Sutherland et al., 2017](#)).

6.2. Knowledge channels

The results of the study lend support to the hypothesis that older participants prefer face-to-face settings (H2), on the grounds that they place importance on social interaction and contextual understanding in their learning choices ([Schuknecht & Schleicher, 2020](#)). Digitalisation has advanced the quality of online offerings, but traditional learning environments continue to provide familiarity and comfort for older farmers. This finding is consistent with earlier studies that emphasised the value of hands-on, social learning experiences for this demographic ([Fleige & Robak, 2018](#)).

The results pertaining to Hypothesis 2 corroborate that older participants exhibit a preference for face-to-face settings due to their need for social interaction. The recommendations thus advocate for a balanced integration of traditional and digital learning methodologies, incorporating detailed information about event formats and technology utilization, alongside individualised adaptations and support

mechanisms for various age demographics.

6.3. Media competence and online training

In relation to media competence, participants who self-assessed their digital skills as higher were more inclined towards online formats, thus confirming H3. This aligns with research highlighting media competence as a critical enabler for engaging with digital learning environments ([Bundesministerium für Bildung, Wissenschaft und Forschung, 2018](#); [Huda & Hashim, 2022](#)). The findings emphasise the necessity for targeted initiatives to enhance media competence, particularly among participants with lower digital literacy.

Hypothesis 3. addressing media competence, confirms the correlation between higher self-assessed digital competence and preference for online formats. The derived recommendations encompass targeted training initiatives to enhance media competence, support provisions for participants with lower digital literacy, and staff development programs for creating engaging online learning environments.

It is imperative to acknowledge that farmers are already embedded in informal digital knowledge networks when formulating these efforts. Social media platforms such as Twitter and WhatsApp facilitate the rapid exchange of practical solutions and feedback among peers, helping farmers to validate methods and find answers to real-world challenges ([Rust et al., 2022](#); [Skaalsveen et al., 2020](#)). Furthermore, the utilization of government websites for accessing formal information, such as subsidies, demonstrates that farmers engage with codified knowledge, yet frequently require interpretive assistance from advisors to act upon it ([Sutherland et al., 2017](#)). Consequently, efforts to enhance media competence must encompass the navigation of institutional portals and the evaluation of the credibility of diverse sources. It is imperative to emphasise that critical engagement remains essential, as the risk of social media bubbles and content distortion persists.

6.4. Media competence

The fourth hypothesis, which proposed that older participants have lower media skills than younger participants, was confirmed. Younger participants demonstrated a stronger preference for digital formats and higher self-assessed digital competence, reflecting the broader societal trend of younger generations being more digitally native ([Morris & Rohs, 2021](#)). However, this generational divide poses challenges for the inclusive design of digital learning environments, which must accommodate varying levels of media competence.

The integration of digitalisation into agricultural education offers opportunities for individualised and flexible learning, but also requires careful attention to didactic design ([Aschemann & Russ-Baumann, 2023](#)). A differentiated approach that considers learners' demographics, such as age, education, and occupational status, is essential for addressing their specific needs ([Fleige & Robak, 2018](#)). Furthermore, the challenges of technostress, as outlined in the theoretical background, must be addressed through the provision of training and support to ensure the effective and sustainable use of digital media ([Abbas et al., 2023](#)). The findings emphasise the importance of fostering a learning culture that supports both formal and informal learning contexts. Digitalisation presents new opportunities for education, but these must be coupled with reflective media didactics to create learning environments that are inclusive, effective, and adaptable to diverse learner needs.

The confirmation of Hypothesis 4, indicating higher digital competence among younger participants, presents challenges for inclusive design implementation. The corresponding recommendations incorporate the consideration of diverse demographic requirements in educational program design, integration of varied learning methodologies (field visits, practical sessions, online learning), and attention to educational attainment levels in event planning. Gender-specific approaches warrant consideration, given women's tendency to favour

online learning while men demonstrate preference for field visits. Particular attention should be directed toward ensuring high-quality online learning environments.

In this context, digital networks such as Twitter or topic-specific WhatsApp groups serve as significant channels for knowledge diffusion, especially in niche farming practices like no-till farming (Skaalsveen et al., 2020). These networks facilitate connections among farmers with similar outlooks, provide a platform for the validation of non-mainstream practices, and allow for geographical flexibility. Trust remains a central factor in this regard: digital information is more likely to be accepted if it originates from peers or advisors perceived as experienced and credible—often those who are themselves farmers (Sutherland et al., 2017). In a similar vein, the agrotourism sector exemplifies how farmers often circumvent conventional advisory systems, instead leveraging peer and expert networks from diverse domains (Sutherland et al., 2017). Consequently, educational strategies must support these hybrid knowledge ecosystems by encouraging inclusive access, digital moderation, and scientific grounding in peer-based exchanges.

7. Implication of the study

7.1. Theoretical contribution to agricultural education

The present study makes a significant theoretical contribution to the discourse on agricultural adult education by analysing how digital transformation affects learning preferences and participation in a sector that is often underrepresented in educational research. In contrast to the majority of extant studies, which concentrate on formal, urban, or institutional learning contexts, this research focuses explicitly on Austrian farmers—individuals whose educational experiences are typically shaped by practical application, peer interaction, and context-specific knowledge.

The incorporation of demographic variables such as age and employment status alongside media competence serves to expand theoretical models like DigComp 2.2 AT into the agricultural sector, thereby highlighting the sector-specific challenges and enablers of digital learning. The results demonstrate that media competence is a decisive factor in determining whether farmers are willing and able to engage with online training formats. This finding serves to elevate digital literacy from a mere supporting role to a central prerequisite for participation in agricultural education in the digital age.

Furthermore, the study refutes certain oversimplified assumptions, such as the notion that part-time farmers are by default more inclined to use digital formats. This refutes the notion that digital readiness is uniform across different demographics and highlights the need for context-sensitive theoretical frameworks. The integration of informal learning cultures, peer-driven knowledge systems, and the high importance of trust and practical applicability into future models of rural adult education is therefore recommended.

7.2. Practical implications for agricultural training

The findings of this study also have extensive practical ramifications for the conception and execution of effective agricultural training programmes. A key finding is that media competence is not uniformly distributed, and that it exerts a substantial influence on farmers' receptiveness to digital learning formats. Consequently, training programmes must commence with targeted digital literacy support, particularly for older farmers or those with limited prior exposure to online platforms. This could entail the provision of tutorials on navigating mobile applications and online courses, as well as training in critically evaluating digital information.

Concurrently, the study validates the persistent significance of experiential learning, particularly for full-time farmers and older participants. Blended learning models must, therefore, be more than a

simple combination of digital and analog formats; they must be meaningfully aligned with the realities of farming. On-farm demonstrations, excursions, and in-person workshops should be complemented by digital components, such as short videos, mobile-accessible materials, or moderated online forums, to ensure continuity and facilitate deeper learning beyond the immediate face-to-face interactions.

Another important practical implication lies in the integration of informal digital knowledge channels. Farmers already make active use of WhatsApp groups, online forums, and social media platforms to exchange information, solve problems, and stay up to date. These networks are often characterised by a high level of trust and contextual relevance. Education providers and advisors would be wise to pay heed to these spaces and support them by curating and moderating scientifically sound content. Engaging with farmers in these digital communities can allow formal education systems to extend their reach and enhance their credibility.

Moreover, the study emphasises the heterogeneity that characterises the farming community. Gender, education level and farm size have been identified as significant factors in the shaping of learning preferences. To illustrate this point, it is noteworthy that women have been found to exhibit a greater propensity for embracing digital training opportunities, whilst men have been observed to demonstrate a preference for practical, in-person formats. Consequently, educational institutions are obliged to devise flexible, inclusive, and adaptive learning pathways that accommodate these differences. This necessitates the development of mobile-friendly learning materials, the provision of varied instructional formats, and the implementation of individualised support systems.

Finally, the findings emphasise the importance of incorporating trust and relevance into training design. Farmers have been shown to be more likely to engage when educational offerings are co-created with them, reflect their everyday challenges, and are endorsed by their peers. Consequently, advisors and educators must be equipped not only with didactic and technical skills, but also with the ability to build authentic, trust-based relationships within farming communities.

8. Conclusion

The European Commission emphasises the importance of a wide range of skills in meeting today's challenges, with media competence playing a critical role (European Commission, 2023). The survey conducted in this study highlights that mobile devices such as smartphones, laptops, tablets, and PCs are widely used by the educational participants (Dehbi et al., 2023). A significant positive correlation was found between media competence and interest in online education, indicating that individuals with higher levels of media competence are more inclined towards online learning (Jones et al., 2021). However, older participants and those with lower media competence require additional support to engage effectively with digital formats. Gender differences were also observed, with women showing greater interest in online training, while men often preferred more practical, hands-on approaches.

It is imperative to contextualize these findings within the unique learning culture and preferences prevalent in the agricultural sector. Farmers across Europe have been demonstrated to have a strong affinity for practical, context-specific, and peer-based learning formats. Preferences include on-farm demonstrations, hands-on workshops, personalised advice, and participation in farmer networks. Trust in the source of information, as well as the opportunity to share and validate practical experience, are key conditions for engagement with learning environments (Franz et al., 2010; Rust et al., 2022; Skaalsveen et al., 2020).

In light of these findings, a number of practical recommendations are posited for the future design of educational programmes in agricultural learning environments. It is recommended that educational institutions promote media competence among learners by providing detailed guidance on the use of digital tools and offering support tailored to

individual skill levels. Furthermore, the learning environment should be optimised for mobile devices, incorporating app-based solutions for user-friendly access and engagement. Staff training should be targeted, ensuring the design and delivery of high-quality online learning environments that meet learners' expectations and foster motivation.

In the context of agricultural education, this entails cultivating critical digital literacy skills to navigate diverse information sources, such as social media and online farmer communities. As farmers increasingly use digital platforms to access practical knowledge and interact with trusted peers and advisors, education providers and advisory services should support and moderate these informal learning spaces (Sutherland et al., 2017). Farmer-influencers, WhatsApp groups and online forums must be recognised as legitimate extensions of the knowledge ecosystem.

From a didactic perspective, the expansion of online training programmes with diverse media channels, such as instructional videos and social media, has the potential to address the growing demand for flexible learning. It is imperative that programmes take into account gender-related differences, offering customised options such as online modules tailored to the needs of women and practical field visits designed with men in mind. Furthermore, educational levels should be considered, with customised offerings for participants with different qualifications, ranging from online courses for those with compulsory education to hands-on sessions for highly educated professionals.

It is of equal importance to ensure that training programmes are aligned with the motivations and values of diverse farmer groups. These include the desire for time and cost efficiency, staying up to date with research, social connectedness, and trust-based cooperation. Participatory formats, such as co-designed research projects and farmer-led demonstrations, should be prioritised, particularly for organic and diversified farms. The role of advisors in facilitating learning across these networks is critical, and these individuals must be trained to respect and understand the individual contexts, values, and production systems of farmers (Franz et al., 2010).

The findings of this study demonstrate that the learning culture in sustainable animal husbandry in Austria has undergone significant change, driven by digitalisation. Nevertheless, it is important to note that digital tools alone are insufficient. To sustain and expand these advancements, targeted efforts must focus on integrating blended and peer-based learning environments, enhancing media didactics, and building digital trust networks within the agricultural sector.

Addressing individual preferences, demographic differences, and educational needs, particularly those of agricultural learners, is pivotal in creating inclusive and effective educational programmes that meet the current demands of the farming community and support the transition towards sustainable agricultural practices.

9. Limitations and future directions

The evaluation and preliminary design of the questionnaire for the methodological preparation of this study yielded revealing results, highlighting the importance of continuous involvement of those involved in education in the design of comprehensive educational projects and the resulting educational events. The foundation for the questionnaire was laid with the help of literature research, which revealed a paucity of literature on the subject, with many studies focusing on the school sector and relatively few on adult education. Addressing this lacuna is imperative for future studies, which could be achieved by conducting systematic reviews and meta-analyses of adult education research from adjacent fields to identify transferable insights. Collaborating with international institutions specialising in adult education might also provide valuable benchmarks and comparative perspectives. The design of the questionnaire was subject to critical scrutiny. In the field of agricultural training and continuing education, the only studies available are those conducted by the University of Agricultural and Environmental Education, which are carried out

approximately every five to six years. This limitation hindered the identification of comparable studies for the questionnaire. The establishment of regular and coordinated data collection efforts across multiple institutions could potentially bridge this gap. Furthermore, the formation of partnerships with agricultural education networks in other countries could contribute to the development of a more robust comparative framework. In the context of a continuous improvement process, the collection of additional data would be advantageous in the future, as it would facilitate the customisation of training to the target group. The employment of larger datasets and longitudinal studies could empower researchers to more profoundly comprehend and address the multifaceted needs of learners. The incorporation of diverse sampling strategies would also guarantee the representativeness of the findings with respect to different demographic and regional groups, thereby enhancing the applicability of the results. A longitudinal study over an extended period could illuminate the long-term implications of digital learning environments on educational practice in sustainable animal husbandry in Austria, potentially revealing changes in learning motivation, knowledge transfer, and knowledge application over time. The incorporation of a mixed-methods approach in longitudinal research, integrating quantitative analyses of learning outcomes with qualitative insights into learner perceptions and behavioural shifts, could enhance the study's overall rigour and depth. A qualitative study could provide a more in-depth exploration of farmers' experiences and offer insights into their perceptions, challenges, and recommendations for the integration of digital technologies in education. Semi-structured interviews or focus groups could generate rich, context-specific data, and including participants with diverse farming profiles could enhance the generalizability of the recommendations. The development and validation of evaluation models for digital learning scenarios could facilitate more effective measurement and assessment of the effectiveness and benefits of such approaches. These models could incorporate metrics for engagement, learning outcomes, and the practical application of knowledge, offering a more comprehensive understanding of the impacts of digital education. The integration of adaptive learning approaches into digital teaching methods could enable personalised educational experiences and meet the individual learning needs of participants. Future research could focus on aligning adaptive learning technologies with the specific requirements of agricultural education, addressing challenges such as varying levels of media competence among learners and ensuring inclusivity in digital education.

CRediT authorship contribution statement

Rita Stampfl: Writing – original draft. **Michael Prodingner:** Writing – review & editing, Conceptualization. **Johanna Prodingner:** Writing – original draft.

Data availability statement

The datasets generated and analysed during the current study are not publicly available due to privacy and ethical considerations protecting participant confidentiality. Therefore, the data can only be provided by the corresponding author upon request.

Ethical statement

This study was conducted in strict compliance with all relevant laws and institutional guidelines. Informed consent was obtained from all participants prior to their inclusion in the study. The privacy rights of all human subjects were rigorously observed and maintained. The research adhered to the principles outlined in The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans. Review and approval by an ethics committee was not needed for this study because the data was collected exclusively using non-invasive methods and was limited to everyday topics with no particular

ethical relevance. No sensitive personal data within the meaning of the European General Data Protection Regulation (GDPR) was collected.

Declaration of the use of AI

During the preparation of this work the authors used ChatGPT and DeepL Write in order to prove language and readability. After using this tool/service, the authors reviewed and edited the content as needed and takes full responsibility for the content of the publication.

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The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

- Abbas, A., Ar, A. Y., & Hosseini, S. (2024). A global perspective of government initiatives to support higher education during the COVID-19 pandemic: A systematic review of literature. *Research in Globalization*, 8, Article 100202. <https://doi.org/10.1016/j.resglo.2024.100202>
- Abbas, A., Rincón, G. B., Wang, L., & Siddiqui, M. K. (2023). Investigating the impact of technostress on perceived hybrid learning environment and academic performance. *Electronic Journal of e-Learning*, 21(4), 382–393. <https://doi.org/10.34190/ejel.21.4.3084>
- Alberti, V., Strauch, A., & Brandt, P. (2022). Digitale Kompetenzen Lehrender—Zur Möglichkeit ihrer Integration in Modelle generisch pädagogischer Kompetenzen am Beispiel von GRETA. *Digitalisierung und Erwachsenenbildung. Reflexionen zu Innovation und Kritik*, 44–45.
- Arnold, P. (2013). *Handbuch E-Learning: Lehren und Lernen mit digitalen Medien*. Bertelsmann Verlag.
- Aschemann, B., & Russ-Baumann, C. (2023). Glossar der Begriffe im Wandel. <http://nbn-resolving.de/urn:nbn:de:0111-pedocs-263934>, 2nd ed..
- Bundesministerium für Bildung, Wissenschaft und Forschung. (2018). Medienkompetenzen. Überfachliche Kompetenzen. <https://www.bmbwf.gv.at/The-men/schule/schulpraxis/uek/medien.html>.
- Bundesministerium für Digitalisierung und Wirtschaftsstandort. (2021). *Digitales Kompetenzmodell für Österreich—DigComp 2.2 AT*. Selbstverlag.
- Dehbi, A., Dehbi, R., Bakhoui, A., & Talea, M. (2023). Survey Analysis of Students and Teachers' Perceptions of E-Learning and M-Learning in Morocco. *International Journal of Interactive Mobile Technologies (IJIM)*, 17(03), 102–122. <https://doi.org/10.3991/ijim.v17i03.36325>.
- Döring, N., & Bortz, J. (2016). *Forschungsmethoden und Evaluation in den Sozial- und Humanwissenschaften*. Springer Berlin Heidelberg. <https://doi.org/10.1007/978-3-642-41089-5>
- Erpenbeck, J., Sauter, S., & Sauter, W. (2015). *E-Learning und Blended Learning: Selbstgesteuerte Lernprozesse zum Wissensaufbau und zur Qualifizierung*. Fachmedien Wiesbaden: Springer. <https://doi.org/10.1007/978-3-658-10175-6>
- Europäische Kommission. (2023). *Kompetenzen und Qualifikationen—Beschäftigung, Soziales und Integration—Europäische Kommission [European Commission]. Kompetenzen und Qualifikationen*. <https://ec.europa.eu/social/main.jsp?ca tid=1146&langid=de>.
- Fleige, M., & Robak, S. (2018). Lehr- und Lernkultur in der Erwachsenenbildung. In R. Tippelt, & A. von Hippel (Eds.), *Handbuch Erwachsenenbildung/Weiterbildung*. Springer Fachmedien.
- Franz, N., Piercy, F., Donaldson, J., Richard, R., & Westbrook, J. (2010). How farmers learn: Implications for agricultural educators. *Journal of Rural Social Sciences*, 25(1). <https://egrove.olemiss.edu/jrss/vol25/iss1/4>.
- Gruber, N. (2013). Definition: EB in Österreich : Themen :: erwachsenenbildung.at [Erwachsenenbildung.at]. Was ist Erwachsenenbildung? Definition und Gegenstandsbestimmung. https://erwachsenenbildung.at/themen/eb_in_oesterreich/definition/.
- Huda, M., & Hashim, A. (2022). Towards professional and ethical balance: Insights into application strategy on media literacy education. *Kybernetes*, 51(3). <https://doi.org/10.1108/K-07-2017-0252>. Article 3.
- IATE Interactive Terminology for Europe. (2022). *Synchron. IATE European Union terminology*. Available at: <https://iate.europa.eu/entry/result/1439817/de>.
- Jones, N., Devonald, M., Dutton, R., Baird, R., Yadete, W., & Gezahegne, K. (2021). Disrupted education trajectories: Exploring the effects of Covid-19 on adolescent learning and priorities for “building back better” education systems in Ethiopia. *Development Policy Review*, 40(S2), e12607. <https://doi.org/10.1111/dpr.12607>.
- Kerres, M. (2016). E-Learning vs. Digitalisierung der Bildung: Neues Label oder neues Paradigma?. In A. Hohenstein, & K. Wilbers (Eds.), *Hrsg.), handbuch E-learning. Fachverlag deutscher wirtschaftsdienst*, 61.
- Kirner, L., Payrhuber, A., Prodinger, M., & Hager, V. (2019). *Professionalisierung der Weiterbildung und Beratung in der österreichischen Rinder- und Schweinehaltung* (S. 225).
- Kirner, L., Prodinger, M., & Hager, V. (2020). *Professionalisierung der Weiterbildung und Beratung in der österreichischen Rinder- und Schweinehaltung* (S. 87).
- Middendorf, W. (2022). Digitale Lernumgebungen—Didaktische Möglichkeiten und praktische Fragen. <https://doi.org/10.25656/01:24223>.
- Morris, T. H., & Rohs, M. (2021). Digitization bolstering self-directed learning for information literate adults—A systematic review. *Computers and Education Open*, 2, 1–11. <https://doi.org/10.1016/j.cao.2021.100048>
- Nachhaltige Tierhaltung Österreich. (2022). *Bildung. nutztier.at*. <https://www.nutztier.at/bildung/>.
- Rummier, K., Koppel, I., Aßmann, S., Bettinger, P., & Wolf, K. D. (2021). Editorial: Lernen mit und über Medien in einer digitalen Welt. *MedienPädagogik: Zeitschrift Für Theorie Und Praxis Der Medienbildung*, i.
- Rust, N. A., Stankovics, P., Jarvis, R. M., Morris-Trainor, Z., De Vries, J. R., Ingram, J., Mills, J., Glikman, J. A., Parkinson, J., Toth, Z., Hansda, R., McMorran, R., Glass, J., & Reed, M. S. (2022). Have farmers had enough of experts? *Environmental Management*, 69(1), 31–44. <https://doi.org/10.1007/s00267-021-01546-y>
- Schuknecht, L., & Schleicher, A. (2020). Digitale Herausforderungen für Schulen und Bildung. In *Ifo-schnelldienst* (Bd. 73, Nummer 5, S (pp. 68–70)).
- Seufert, S., & Meier, C. (2017). E-Learning in Organisationen. Nachhaltige Einführung von Bildungsinnovation. In *Lehrbuch für Lernen und Lehren mit Technologien* (2nd ed.) Informationszentrum (IZ) Bildung.
- Skaalsveen, K., Ingram, J., & Urquhart, J. (2020). The role of farmers' social networks in the implementation of no-till farming practices. *Agricultural Systems*, 181, Article 102824. <https://doi.org/10.1016/j.agsy.2020.102824>
- Sutherland, L.-A., Madureira, L., Dirimanova, V., Bogusz, M., Kania, J., Vinogradnik, K., Creaney, R., Duckett, D., Koehnen, T., & Knierim, A. (2017). New knowledge networks of small-scale farmers in Europe's periphery. *Land Use Policy*, 63, 428–439. <https://doi.org/10.1016/j.landusepol.2017.01.028>
- Tippelt, R., & von Hippel, A. (2018). *Handbuch Erwachsenenbildung/Weiterbildung* (6th ed., Bd. 1).
- University of Alberta Centre for Teaching and Learning. (2016). What is blended learning? *Pressbook*.
- Wannemacher, K., Jungermann, I., Scholz, J., Tercanli, H., & Villiez, A. (2016). Digitale Lernszenarien im Hochschulbereich. In *hIS-Institut für hochschulentwicklung* (Hrsg.), *Arbeitspapiere des hochschulforums Digitalisierung*. Stifterverband - Verwaltungsgesellschaft für Wissenschaftspflege mbH.
- Zawacki-Richter, O. (2017). *Entwicklung von wissenschaftlichen Weiterbildungsprogrammen im MINT-Bereich* (Götter, Roman [Hrsg.], Röbken, Heinke [Hrsg.], Haubenreich, Jutta [Hrsg.], Zawacki-Richter, Olaf [Hrsg.], & Arnold, Marlen [Hrsg.], Hrsg.). pedocs.