

Acceptance and Usability of Interactive Infographics in Online Newspapers

Sandra Zwinger, Julia Langer, Michael Zeiller

Department Information Technology and Information Management
University of Applied Sciences Burgenland
Eisenstadt, Austria

sandra.zwinger@live.at, 1410639004@fh-burgenland.at, michael.zeiller@fh-burgenland.at

Abstract— Interactive infographics are a powerful tool to represent and communicate complex information. In data-driven journalism journalists use interactive infographics to explain new insights and facts while telling complex stories on the basis of retrieved data. However, readers of online news are still unexperienced while using interactive infographics. The results of a user survey among readers of online newspapers show how readers use and interact with interactive infographics in online newspapers. To improve the acceptance among users and to identify success factors of their utilization the results of a usability study of interactive infographics are presented.

Keywords- interactive infographics; information graphics; information visualization; interaction; data-driven journalism; online journalism; online newspaper; usability; success factor

I. INTRODUCTION

Data-driven journalism (short: DDJ) collects, evaluates, interprets and presents large amounts of data [1] [2]. Lorenz [3] defines data-driven journalism as a workflow, where data is the basis for analysis, visualization and – most important – storytelling. Data-driven journalism explains new insights and clarifies facts while telling complex stories on the basis of large amounts of retrieved data. In data-driven journalism information graphics can help a journalist to tell a complex story [2] [4]. In the reporting phase, information visualization helps journalists to identify themes and questions, to identify outliers or to find typical examples. Journalists tell stories based on their investigations and data visualization is an appropriate communication medium for storytelling [5]. In online newspapers we can find an emerging number of stories that are enhanced with narratives including complex graphics and especially interactive infographics.

Information visualization is the use of (interactive) visual representations of abstract data to amplify cognition [6] [7]. It supports users to perceive, recognize and interpret complex information effectively and efficiently. However, users have to be able to easily access infographics with a high degree of usability. In online media infographics can be interactive, i.e., they provide users with one or more options to control which and how much information shall be shown. However, adding interactivity introduces an additional level of required skills to users (i.e., data literacy).

Although interactive infographics are increasingly used in online media, readers really have to be able view them and

to use the control tools intuitively. Thus, we analyze how readers of online newspapers assess the availability and findability of interactive infographics, which types of interaction they utilize and which skills they need. To identify success factors of interactive infographics in online newspapers and to improve the user experience a usability study of infographics in four German-speaking online newspapers is presented.

II. INTERACTIVE INFOGRAPHICS

Information graphics (short: infographics) combine graphics, image and text to communicate information, data or knowledge effectively using graphic visual representations [8] [9] [10]. They are used to communicate complex topics efficiently and draw the attention of percipients to them. Infographics provide the percipient with new insights and a quick overview on complex facts on subjects like politics, science, technology, and nature that are hard to understand just using text-based information.

A. Types of Infographics

There are three basic types of infographics (Fig. 1): [11] [12]

- Principle representation
- Cartographic infographics
- Statistics chart

The principle representation – also denoted as functional graphics – describes complex causal relationships in real or abstract form. Principle representations are composed of fact graphics, structure graphics, and process graphics. The cartographic infographics (map) convey space-oriented information in a clearly arranged, simple and understandable way that provides orientation. Event space maps, topic maps, and weather maps belong to this type of infographics. [11] [12]



Figure 1. Three types of infographics (Source: [11]).

Statistics charts help to illustrate quantities and compare them, especially large, complex sets of numbers and relations. This type is composed of pie chart, bar chart, curve chart, area diagram, scatter plot, Sankey diagram, and radar chart. [11] [12]

B. Interaction in Infographics

Many computer systems offer interactive features to support human-computer interaction. However, the interactive elements have to be accessed and utilized by users easily. We differentiate between a control dimension and a transmission dimension that allows the system to react on user input. The control dimension is subdivided into options for selection (selection of existing content; e.g., click on a hyperlink) and options for modification (change of system range by input; e.g., input of text) [13]. In the context of infographics there exist several methods of interaction to manipulate a visual representation, like scrolling, overview plus detail, or focus plus context, filtering, or data reordering [14].

Weber and Wenzel [15] define interactive infographics as a visual representation of information that integrates several modes (at least two), e.g., image/video, spoken or written text, audio, layout, etc. (image mode is constitutive), to a coherent ensemble that offers at least one option of control to the user. The provided option of control can be, e.g.,

- Start or Stop button
- Forward or backward button
- Menu item to select
- Timeline or time controller
- Filter, data request or input box

C. Classification of Interactive Infographics

Interactive infographics can be characterized by five features which cover interaction as well as narrative issues: degree of interactivity, activity model, communicative intent, “W-questions” and topic [15] [16]. Other features like genre or visual narrative might be used as well [17]. The biggest influence on the usability of interactive infographics is induced by the degree of interactivity and the activity model.

The degree of interactivity of interactive infographics is made up of three levels [15]:

- Low interactivity
- Medium interactivity
- High interactivity

A low level of interactivity allows users to navigate within the infographics and select content, e.g., by using internal links, zooming, mouseover effects for showing details, Next or Start buttons, but without changing the infographics. On a medium level of interactivity users can manipulate the infographics, e.g., by a timeline slider or menu items, thus applying changes and comparing information. A high level of interactivity enables users to explore the infographics and to interact with data and information, e.g., by inputs, filtering, or data retrieval.

Interactive infographics can be classified by three grades of the activity model identifying the way users can interact [15] [16]:

- Linear
- Nonlinear
- Linear-nonlinear

Linear interactivity enables the user to move (forward or backward) through a predetermined linear sequence [18]. The linear type is based on a step-by-step course defined by the author, i.e., author-driven [17]. The user follows a strict path and does not have to explore the visualization by himself. Navigation tools like Start, Stop, Forward, Backward or Next are used to navigate in a linear course. [16]

A nonlinear visualization does not provide a prescribed ordering and requires a high degree of interactivity by the user – its narrative being reader-driven [17]. Nonlinear infographics provide the user with many ways to explore and query the visualization, including free exploration without predefined navigation paths. Navigation tools for nonlinear infographics include filter, input box, data query, or brushing. [16]

The linear-nonlinear type is a hybrid of the author-driven and reader-driven approach that enables the author to communicate his message using a predefined path, but still allowing the user a certain amount of selection. Navigation tools for linear-nonlinear infographics include interactive timelines, time controller, and integrated navigation menu. [16]

III. ACCEPTANCE OF INTERACTIVE INFOGRAPHICS BY READERS OF ONLINE NEWSPAPERS

During an evaluation research investigating the application of interactive infographics in German-speaking newspapers it turned out that interactive infographics are hard to identify in online newspapers [19]. Most newspapers have no dedicated sections aggregating interactive infographics and even the integrated search function often fails. Therefore readers will find it hard to identify this special type of infographics and use the interactive control elements.

In particular, in the two Austrian online newspapers „Der Standard“ and „Kurier“, that had been evaluated by Zwinger [19], it was difficult to identify interactive infographics. Therefore, we analyze how Austrian readers of online newspapers assess the availability and findability of interactive infographics and how they use the facilities for interaction. Readers of online newspapers are case by case users, but typically not frequent users of interactive infographics and should be able to easily access this innovative type of visualization. Our goal is to point out whether readers of online newspapers search purposeful for interactive infographics or just use them by pure chance. We examine how laborious and time-consuming readers estimate searching for infographics. The intensity of the use of infographics and the frequency of the utilization of the individual facilities for interaction are determined.

A. Method

A quantitative research approach has been chosen to identify the opinion of readers of online newspapers concerning interaction in infographics. Since it can be assumed that the target group is familiar with online tools, we chose to conduct an unrepresentative online survey. The online survey was made up of 24 questions that included both closed questions (single choice, multiple choice) and matrix questions with different evaluation scales.

Only readers of online newspapers have been surveyed. Persons that participated in the survey, but did not read online newspapers, were identified at the beginning using a knockout question. The survey was published in the off-topic forum of the Austrian newspaper “DerStandard”, on the Facebook page of the Austrian newspaper “Kurier”, and additionally on the Facebook account of one of the authors and among students of the University of Applied Sciences Burgenland [20]. Survey period: June and July 2016.

259 persons participated in the survey. Due to the research design mainly Austrian readers of online newspapers have been surveyed. 215 persons (83.01 %) answered the preceding knockout question positive and were identified as readers of online newspapers. The following results of the survey refer to this group (N=215) [20].

B. Results

86.98 % of the respondents (187 persons of 215) declared that they deliberately take a look at interactive infographics. In a follow-up question the newspaper readers were asked why they view interactive infographics. The most frequent reasons, that have been mentioned, correspond to typical advantages of infographics: illustration of all relevant numbers/facts (77.54 %), a clearly structured overview (63.64 %), or good memorability due to the combination of text and image (51.34 %). Table 1 summarizes those reasons that have been mentioned most frequently (multiple references possible).

The participants could rate on a five-point Likert scale (scale from “very intensive” to “less intensive”) how intensively they use the provided possibilities of interaction. More than half of the participants use them “moderately intensive” (54.01 %, 101 persons). The infographics are “very intensively” used by only 6.42 % respondents (12 persons). 25.13 % (47 persons) used them “intensively”.

TABLE I. REASONS FOR USING INTERACTIVE INFOGRAPHICS [20]

Answer option	Percentage	#
Illustration of all relevant numbers/facts	77.54 %	145
Clearly structured overview put into graphs	63.64 %	119
Good memorability due to the combination of text and image	51.34 %	96
Relevant information can be filtered and visualized	34.22 %	64
Easy search for data/information	26.74 %	50
I do not like to read long text	21.93 %	41
Offers to view data/information in various representations	16.04 %	30
Other	1.60%	3

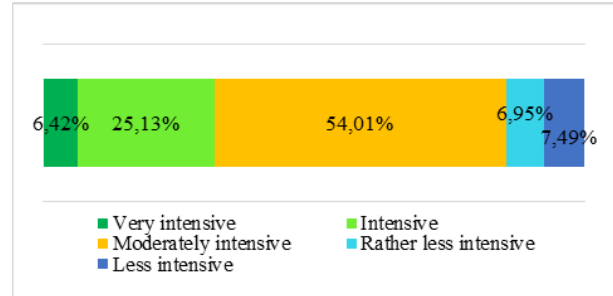


Figure 2. Intensity of using the facilities of interaction [20]

The option “rather less intensive” has been named by 13 persons (6.95 %) and there are 14 users (7.49 %) who use the infographics “less intensive” (Fig. 2).

Linear, nonlinear and linear-nonlinear infographics provide different mechanisms to control the graphics. Typically used control elements like start/stop button, menu items or filters have been investigated. The respondents of the survey could rate on a five-point Likert scale (scale from “very frequently” to “never”) how frequently they apply these control elements (Table 2).

The respondents (N=187) have been asked whether those control elements can be recognized easily and are marked sufficiently. Only 2.67 % of the respondents (5 persons) consider the control tools as “very well recognizable”. 33.16 % (62 persons) consider them as “good recognizable” and the majority of 37.97 % (71 respondents) consider the control tools as “moderately recognizable”. 20.32 % respondents (38 persons) have not been satisfied with the visibility of the control tools and assessed them as being “poorly recognizable”. One respondent (0.53 %) did not find the control tools at all and answered “not recognizable” (10 persons, i.e., 5.35 %, did not specify) (Fig. 3). Obviously there is need for action to support especially casual users in taking advantage of the interactivity offerings.

Only 24.06 % of the participants in the survey (45 persons, N=187) declared that they actively search for interactive infographics in online newspapers. But even those people had difficulties to find interactive infographics. 77.78% of this group of users highly interested in interactive infographics (N=45) is not satisfied with the result when they actively search for infographics in online newspapers.

TABLE II. FREQUENCY OF USE OF CONTROL TOOLS [20]

n=187	Very frequently	Frequently	Occasionally	Seldom	Never
Start, Stop button	11.23 % 21	25.67 % 48	35.83 % 67	22.46 % 42	4.81 % 9
Forward, Backward	10.70 % 20	29.95 % 56	39.57 % 74	18.18 % 34	1.60 % 3
Navigation bar	26.20 % 49	46.52 % 87	19.25 % 36	6.42 % 12	1.60 % 3
Filter	20.86 % 39	36.36 % 68	26.74 % 50	13.37 % 25	2.67 % 5
Timeline slider	9.09 % 17	25.13 % 47	37.97 % 71	21.93 % 41	5.88 % 11
Input box	3.21 % 6	18.18 % 34	35.29 % 66	32.09 % 60	11.23 % 1

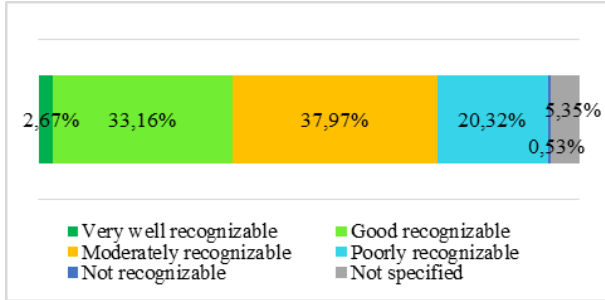


Figure 3. Perceptibility of control tools [20]

They would endorse (97.78 %) that online newspapers promote interactive infographics, e.g., by dedicated menu items or other kinds of distinction.

The majority of the participants – 75.94 % (142 respondents, N=187) – do not search actively for articles that contain interactive infographics, i.e., they are very casual users of this type of information visualization. Nevertheless, three-quarters of those casual users (74.65%, 106 persons, N=142) mentioned that they would use infographics more often, if they would be easier to find.

A barrier for casual users that can hinder them using interactive infographics might be due to a lack of experience and IT literacy respectively data literacy. While 25.67 % of the respondents do not need additional computer and IT skills for using interactive infographics, the majority of readers of online newspapers indicated that computer/IT knowledge is necessary – at least a basic knowledge (63.64 %, N=187) (Fig. 4).

Despite the problems users of interactive infographics in (Austrian) online newspapers might encounter, the majority of the respondents of the survey (73.26 %) would appreciate an increasing offering of infographics (only 1.60 % disapproved, 25.13 % were indifferent to an increase). The respondents would prefer if more interactive infographics would be published concerning science (24.60 %), economics (22.99 %), consumption (10.70 %), crime (9.63 %) and politics (8.56 %) (note: user hold the opinion that 53.48 % of published infographics are currently on politics).

IV. USABILITY STUDY OF INTERACTIVE INFOGRAPHICS IN ONLINE NEWSPAPERS

The results of the first study revealed a significant lack of convenience and usability during the utilization of interactive infographics. Therefore, in a second study by Langer [21] we analyzed the usability of infographics. Special focus of that study was the identification of weak spots and success factors for designing interactive infographics in online newspapers that ensure a positive user experience to readers.

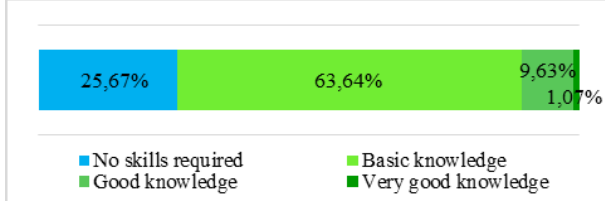


Figure 4. Computer literacy [20]

A. Method

The evaluation of the usability of interactive infographics in online newspapers applies a combination of a questionnaire and the well-known method Thinking Aloud. There exist a number of usability testing methods, but one of the easiest and frequently used methods is Thinking Aloud (Think-Aloud) [22] [23]. When using the thinking aloud protocol users are encouraged to speak out loud what they think (whatever comes in their mind) while they are performing a specific task - i.e., while they are using and exploring the interactive infographics. The spoken word of the participants are recorded (audio, video) and can be transcribed and analyzed afterwards.

The questionnaire follows the ISO standard 9241-110 on ergonomics of human-system interaction [24]. According to the dialogue principles of ISO 9241-110 the questionnaire is divided into the sections *suitability for the task*, *self-descriptiveness*, *conformity with user expectations*, *suitability for learning*, *controllability*, *error tolerance*, and *suitability for individualization*. The participants could rate each item on a four-point Likert scale (scale ‘very negative’ “-” | ‘negative’ “-” | ‘positive’ “+” | ‘very positive’ “++”). Each section is made up of at least two (suitability for learning, error tolerance, suitability for individualization) up to five (conformity with user expectations) individual questions.

Example: *controllability*

- The interactive infographics allows for a cumbersome – easy adoption of navigation tools.
- The interactive infographics offers difficult – easy actions and changes using buttons (e.g., Forward/Back, Next).
- The interactive infographics allows to undo single steps in a complicated way – easily.
- The interactive infographics provides complicated and insufficient – simple and sufficient sorting, filtering and selection of information.

Six interactive infographics have been tested by eight test persons. The infographics had been published in German-speaking newspapers: “Kurier” from Austria, “Spiegel” and “Berliner Morgenpost” from Germany, and “20min” from Switzerland (Figure 5).

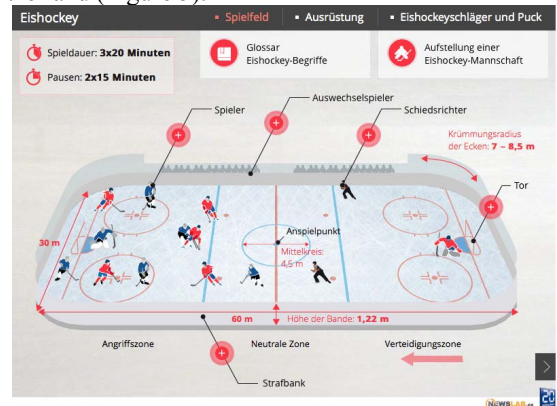


Figure 5. Example linear-nonlinear type “Ice hockey” [29]

Two infographics are of linear type [25] [26], two of the nonlinear type [27] [28] and two of the linear-nonlinear type [29] [30].

The tests have been conducted in January 2017 by eight persons at the age of 18 to 30 years. Four of them had been using interactive infographics before, but four of them had no experiences with interactive infographics. Each test started by presenting the first infographic to the test person. The test person had to explore the interactive infographic and had to speak out loud what he/she thinks at the same time. After that the test person had to fill in the questionnaire. This procedure was repeated with all six infographics (average duration: 01:10 hh:mm).

B. Results

Users of the linear type infographics do not necessarily need previous experience. The test persons perceived this type as straightforward and simple. This is due to the fact that the linear type provides a step-by-step experience and there are no additional, unnecessary elements of interaction. Users can navigate within the infographics using Forward and Backward buttons. Exploring the infographics corresponded to the expectations of habits of the users (i.e., high conformity with user expectations). The test persons had a good overview of the provided elements of interactions (e.g., buttons). Due to the simple kind of interaction dealing with this type is easy to learn and requires little time. Both examples that had been tested made utilization and orientation easy due to a uniform design and color coding of the interaction elements. However, since this kind of interaction is very simple, there is a risk of being boring and uninspired. Users would like to have more means of interaction. Thus, after some time the test persons started to click around to find more interactive elements. As with example [25] the worst case might be that users question whether the infographic is really interactive.

Both examples of the linear-nonlinear type did not require previous experience since they offered explanations and tips and used understandable terms, abbreviations and symbols. This type has been perceived as exciting, but at the same time as straightforward and having a clear design. The linear-nonlinear type offers more interaction and adapts to the individual needs of users. The combination of structured information delivery (linear activity) and individual exploration (nonlinear activity) supports fast and easy adoption. Using a navigation bar and buttons the users can easily move around the infographics. It takes only few steps and little time to reach the required information. Again, uniform design and color coding facilitate orientation and easy handling, since interactive elements can be identified at once. Four test persons had been overtaxed by the high amount of information, while the other four test persons considered all provided information as relevant. This contradiction might be due to the fact that users can decide by themselves whether additional information shall be retrieved or not.

Nonlinear interactive infographics are perceived as creative and thrilling since they offer a large variety of possibilities to individually explore and test the infographics.

However, both examples have been reviewed as being complicated and confusing, because they offered unnecessary control elements for interaction and non-essential information. The amount of presented information and color coding had (negative) influence while getting acquainted. The test persons needed much more time to learn the information architecture and to get familiar with the interaction features and control elements. However, the uniform design of interactive elements provided a good overview. Moving and navigating within the infographics was easy and convenient due to the high degree of freedom. The availability of several items to select, sort and filter allows users to adapt the visualization to their individual needs. However, due to the complex model of interaction the test persons needed previous experience on the topic – but that might have also been caused by the use of terms, abbreviations, icons, and symbols in example [27] and [28].

V. CONCLUSIONS

From the point of view of readers of online newspapers we identified potential for improvement concerning the findability and utilization of interactive infographics. Infographics and especially interactive infographics provide an efficient means to communicate complex information in online journalism. The survey of readers of online newspapers demonstrates that the offering of interactive infographics is highly accepted among users with all levels of user experience. However, users have often difficulties to find infographics in online media. The findability of interactive infographics might be improved by dedicated sections in the online newspapers aggregating infographics (e.g., specific menu items in the main navigation) or by other ways to mark or label interactive infographics. It is often hard for users to recognize that infographics offer interactive features with corresponding control tools. Consequently, those control tools are only moderately or seldom used, thus limiting the chance for users to fully explore the infographics. Media should identify controls for interactivity more clearly to allow users to fully utilize the offer of information of the infographics.

Linear-nonlinear infographics are the most convenient type of interactive infographics to users. Interactive elements have to be distinguishable from pure information. Thus, static elements and interactive elements have to be designed differently. The uniform design of interactive elements allows easy orientation and handling. Infographics of the nonlinear type offer a large variety of possibilities to individually explore the infographics. But they risk being too complex and confusing if a strict design concept is not obeyed and unnecessary control elements for interaction and non-essential information are provided.

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