

Please quote as: Weinert, T.; Thiel de Gafenco, M. & Börner, N. (2020): Fostering Interaction in Higher Education with Deliberate Design of Interactive Learning Videos. In: George, J. F., Paul, S. & De´, R. (Eds.), International Conference on Information Systems (ICIS).

Fostering Interaction in Higher Education with Deliberate Design of Interactive Learning Videos

Short Paper

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Abstract

Interactive learning videos are increasingly used in higher education. By using interactive elements, learners can be actively involved in the learning process to enhance their interactions with the content, other learners, and the teacher. However, there are significant gaps in the design of such interactive learning videos: Mostly, instructors do not know which interaction elements they should use where in the video to support the learning process of their students. Based on a design science research approach, we develop reference guidelines to support developers in creating interactive learning videos in higher education that improve the interaction of learners. Based on Interaction Theory and a systematic collection of requirements from theory and practice, we identify research gaps and try to address them with our reference guidelines. Hence, we contribute to theory by providing generalizable reference guidelines for the development of interactive learning videos in higher education.

Keywords: Interactive Learning Video, Higher Education, Interaction

Introduction

The increasing usage of learning videos for educational purposes is a worldwide trend (Huh et al. 2019). About 73% of all 14- to 29-year-old learners use video platforms to repeat learning content (Rat für kulturelle Bildung 2019). In higher education, learning videos are frequently used to support regular lectures (Meehan and McCallig 2019). Due to the increasing number of students, this medium offers the possibility to give quick and broad access to learning content (Schacter and Szpunar 2015). Moreover, recent studies have shown that the revision and recapitulation of learning material such as texts is more efficient if supported by corresponding videos (Hoogerheide et al. 2019). At the same time, the use of learning videos allows content to be repeated as often as desired and enables students to learn at different speeds (Meehan and McCallig 2019).

However, the lack of interaction within learning videos is often criticized (Brame 2016; Hung et al. 2014; Roth and Koenitz 2019). Missing variety in learning videos leads to learner demotivation (Kim et al. 2015). Interactive videos offer the opportunity to diversify video-based learning activities and may provide students with individual guidance regarding their learning processes (Brame 2016; Liao et al. 2019). The usage of interactive elements, such as simple question types or even complex, decision-driven learning

stories, can improve motivation and learning outcomes while reducing the cognitive load of learners (Liao et al. 2019; Roth and Koenitz 2019), for example, by focusing learner attention on key information (Huh et al. 2019). At the same time, interactive learning videos can be designed to incorporate different types of media to convey the learning content (Liao et al. 2019).

While the usage of interactive videos for learning purposes is an increasing trend, neither research nor practice has a clear understanding of how these interactive elements must be designed to fully harness their capabilities in student learning (Kim et al. 2015; Xie et al. 2011). It mostly remains unclear which interactive elements are suitable for which learning situation and how these elements can be used to enhance the learner's interaction with the learning material, other learners, and the instructor. To address these challenges, we formulate our research question as follows:

RQ: How can reference guidelines support the design of interactive learning videos for higher education?

To answer the proposed RQs, we are following the Design Science Research Approach (Hevner 2007) to design reference guidelines in order to support instructors to create interactive learning videos that address different types of interaction present within the medium itself as well as within the regular lecture. Hence, we will create several interactive learning videos with the help of our guidelines. These videos will serve as a basis for a full-factorial between-subject experiment to examine the effect on central learning outcomes and the design of the interactive learning videos in higher education. To explain and predict the influence of interactive learning videos on motivation and learning success, we draw on Interaction Theory by Moore (1989) as well as Cognitive Load Theory (CLT, Sweller 1994). Concerning the overall research aim, this particular paper is a design-oriented one. As such, the (major) theoretical contribution focuses on the prescriptive design knowledge we gain through the development of reference guidelines as well as their evaluation (Baskerville et al. 2018). The minor theoretical contribution targets the effects of the different interaction types implemented in the videos on key learning outcomes, such as learning success and motivation. This paper is structured as follows: The next section focuses on the theoretical background. Afterwards, we outline how we derive design requirements from theory and practice and describe the developmental process of our guidelines. The paper closes with the next steps of our research endeavor and our expected contributions.

Theoretical Background

Interaction Theory as a Kernel Theory

The meaning of the term “interaction” in different disciplines such as education, psychology, and sociology addresses the interrelation between human beings and their communicative activities with the environment (Heath and Bryant 2013; Oeste-Reiss et al. 2016). Moore (1989) distinguishes between three types of interactions: learner-content interaction, learner-learner interaction, and learner-instructor interaction. We adopt these three types of interaction for our work and define interaction as learning activities including an exchange between learners, instructors, and content (Moore 1989). Referring to Moore (1989), learner-learner interaction describes the interaction between the learners themselves. The interaction enables the direct and indirect exchange between the learners and fosters reflective abilities of learners. Learner-instructor interaction describes the interaction between the learner and the teacher. Not surprisingly, the interaction between learner and instructor usually benefits learner performance (Tang and Hew 2017). The interaction provides an opportunity for learners to actively shape the learning and teaching process with their own ideas and thoughts (Martin and Bolliger 2018). Learner-content interaction describes the interaction between learner and content (Moore 1989). This interaction can change a learner's understanding and perspectives (Martin and Bolliger 2018), as the interaction elements encourage different approaches to understand the learning content.

The usage of interactive learning videos enables an enhanced interaction between learners, instructors, and content (Abrami et al. 2011). Elements that foster synchronous and asynchronous interaction stimulate “the interest in what is to be taught, to motivate the students to learn, to enhance and maintain the learner's interest” (Moore 1989, S.2). On the other hand, these kinds of interactional elements allow learners to focus their attention on the important parts of the video and thus help to avoid overloading of the cognitive capacities of the learners (Sweller 1994). This can help instructors to maximize the videos' utility. The avoidance of cognitive load (CL) is important within the design process of interactive learning videos and

provides a framework to design learning materials (Artino 2008). Due to the limited cognitive capacities of the learner, the learners can only pay attention to a part of the offered information (Brame 2016; Sweller 1994). For example, Brame (2016) suggests the use of signaling elements to focus attention and thus the interaction of learners with specific information. Against this background, a deeper look at the design of interactive learning videos is needed to create high-quality learning material that can foster learner interaction.

Interactive Learning Videos

Operationalization of the term interactivity in educational contexts is quite heterogeneous (Sohn 2011; Stromer-Galley 2004; Wagner 1994). Nevertheless, an immediate association of interactivity and higher instructional quality of learning materials and environments can be found in several studies (Domagk et al. 2010). Based on constructivist approaches to learning, notions of learner engagement, self-directed learning, and active rather than passive learner roles represent independent educational goals rather than means to increase desired learning outcomes (Domagk et al. 2010), thus leading to the immediate association of a higher instructional quality. While interactivity and interaction are semantically related, only a small number of studies discuss interactive elements in an educational context with a profound theoretical underpinning or at least acknowledge possible shortcomings in this regard (Sohn 2011; Walther et al. 2005). Especially for a sound assessment of the associated advantages of interactivity, Stromer-Galley’s (2004) reference to the lackluster employment of the term interactivity holds in so far as it prohibits the operationalization of measurement terms, thus hampering the teaching personnel’s ability to evaluate learning videos’ design. We, therefore, build upon Interaction Theory to define interactive learning videos as a form of media that uses interactive elements for the learner – content interaction as well as elements that mediate other types of interaction, thereby supporting integration into teaching and learning environments of higher education.

Methodology

To develop our reference guidelines, we use the design science research framework suggested by Peffers et al. (2007). The guidelines should enable lecturers to design interactive learning videos that enhance different types of learner interaction. In line with Peffers et al. (2007), we are using a problem-centered approach to design the reference guidelines. By carrying out a systematic literature review, a survey, and a structured platform evaluation of interactive learning video providers, we are able to identify systematic gaps within the deployment of such videos. The DSR approach enables a structured procedure to identify such gaps and to design a generalizable artifact (Peffers et al. 2007). Figure 1 illustrates the approach.

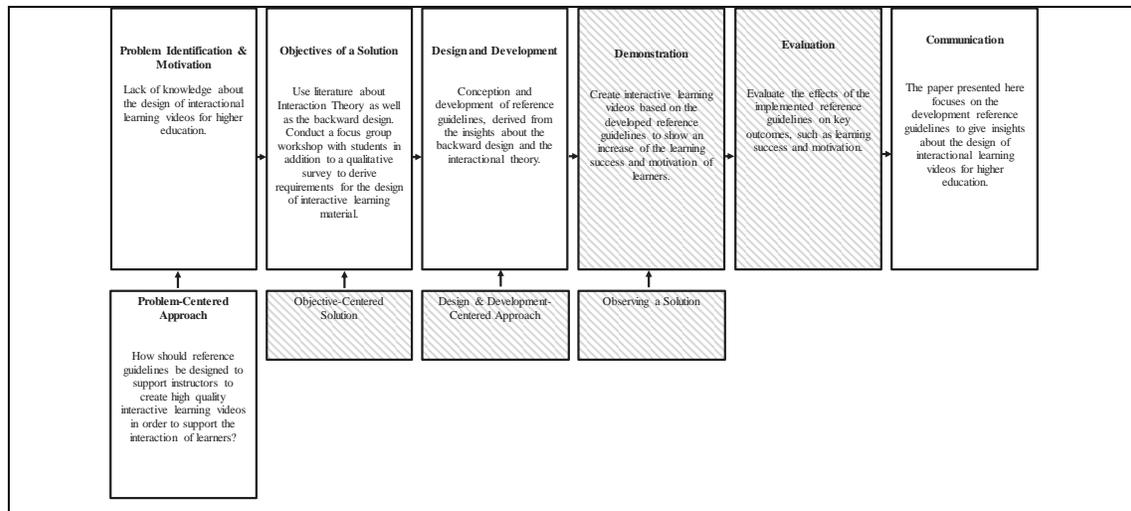


Figure 1. Research approach for developing reference guidelines for the design of interactive learning videos (cross-striped phases are not addressed within this paper). Adapted from Peffers et al. (2007)

Systematic Literature Review

The systematic literature review was conducted in March 2020 using seven databases. Thus, we followed the procedure that is described by Webster and Watson (2002) and Vom Brocke et al. (2009). For the development of our research string, we first conducted a narrative literature search. Based on our findings, we used the following research string: ("interactive") and ("pictures" or "videos" or "material") and ("learning" or "training" or "theory"). We included only peer-reviewed papers in our search. We were able to identify 1,581 papers. Following the approach of Webster and Watson (2002), we analyzed the title, abstract, and keywords of each paper. After the check, 235 studies remained, which we then analyzed in full text. As a result, 27 papers were identified including the backward and forward search.

Survey and Focus Group Workshop

To enrich our findings from the systematic literature review, we conducted a survey and a focus group among university students from Western Europe, who have already used interactive and noninteractive learning videos. In the case of the study, 103 students were asked to give suggestions to improve the existing learning videos for a business informatics lesson. Thus, students were anonymously given the opportunity to express their opinion on an existing (interactive) learning video and to make suggestions for a better implementation of the interaction elements. The learning videos were equipped with various interaction elements, such as easy quizzes, crossroads, or integrated images, whereby their arrangement was based purely on the assumptions of a teacher. In particular, it was noted by the students that existing learning controls were placed in an unstructured way and thus disrupted rather than supported the learning process. Based on these findings, we conducted a focus group workshop consisting of five undergraduate and graduate students ($m=4$, $f=1$) of industrial engineering and engineering. It served as an enhancement to the free-text survey. During the workshop, the participants were asked to develop their ideas of a good learning video, to evaluate the existing interactive learning videos, and to give advice on how to improve them. With the help of Brigg's (2009) brainstorm elements, the arising categories of criticism were determined, prioritized, and embedded together with the survey in the concluding requirements.

Systematic Provider Analysis

To gain additional information about the functionalities of interactive learning videos, we conducted a systematic platform evaluation. Table 1 shows an overview of the different providers.

Table 1. Overview of the Identified Providers		
No.	Name of Provider	Identified Interaction Elements
1	ThingLink	Textual /visual elements, labels, links, crossroads/ tours to other videos.
2	Wirewax	Textual /visual elements, hotspots
3	Vidzor	Textual /visual elements, hotspots, crossroads, skipping, links
4	Storygami	Video elements
5	Metta	Textual /visual elements, audio elements, quizzes, leaderboards
6	Playposit	Quizzes, MC questions, open response questions, surveys, fill in the blank, Forums.
7	Touchcast	Textual /visual elements, documents, links
8	Wootag	Textual /visual elements, hotspots
9	Wideo	Textual /visual elements, audio elements, animations
10	Camtasia	Textual /visual elements, audio elements, quizzes, surveys
11	H5p	Textual /visual elements, crossroads, quizzes, MC questions, drag & drop, fill in the blank

Table 1. Overview of the Identified Providers

Here, we followed the three principles of data collection suggested by Yin (2003). To identify possible providers that offer interactive learning videos, we used two search platforms (Google and Bing). We

selected 11 providers that offer different kinds of (interactive) elements for video-editing that target different types of interaction. This allows us to investigate the functionalities of interactional learning videos for a wide range of application areas.

Development of the Reference Guidelines

Following the DSR approach, we develop reference guidelines in this chapter. In the first step, we address the problem and objective phase of the DSR approach and identify gaps regarding the development of interactive learning videos.

Gap 1: Interaction Possibilities

Many students report the problem that they do not understand how interactive elements work. Brame (2016) also reports about this problem that designers of interactive educational videos often find it confusing which interactions are offered and which are ultimately used in the design of the videos. Against this background, the problem is twofold: On the instructor's side, it is often unclear which (interactive) elements can be used to support the interaction (and for what purpose, see Gap 2) and, on the student's side, it is unclear how these elements work exactly and how they support their learning process (Kutay 2014). For example, several providers offer elements that can encourage students to interact with each other about the content (for example, forums, links, or multi-choice questions), but such features are often either not implemented by teachers or not used by students (Coetzee et al. 2015; Xie et al. 2011). Several students criticized the lack of exchange with other students. Moreover, the time-consuming exchange between students and teachers was seen as an obstacle because the students lacked the reference to the learning material. This is problematic because the interaction between the instructor and the learner and between the learner and the learner is important for reflecting on learning content (Carneiro et al. 2019; Zhang et al. 2006).

Gap 2: Interaction Element Design

Due to the wide range of functions of elements that foster interaction, instructors are often overwhelmed by the question of which elements can be used to support the interactions of the learners (Triglanos et al. 2017). This can lead to excessive and non-targeted use of interaction elements. Huh et al. (2019), for example, reports that excessive use of interaction elements greatly increases the cognitive load on learners. We have received similar reports from the student survey. Especially with complex content, students miss interactional elements that would allow them to interact with other students. In contrast, when using such elements with simpler content, too many interactions are perceived as annoying (Brame 2016). Against this background, we concluded that it is important to adapt the elements to the learning situation and learning goals.

Gap 3: Assessment of the Interaction Success

Many providers offer assessment tools to control the learning progress of learners (Brame 2016; Hoogerheide et al. 2019; Triglanos et al. 2017). Through multiple-choice questions and links (partly in connection with pictures and text elements), the learning process can be assessed. However, since the learning videos often represent compact learning units (Brame 2016), it can be difficult to place the elements in such a way that the desired effects occur: On the one hand, to uncover possible problems of understanding (Lawson et al. 2006) and on the other hand to encourage learners to reflect more deeply on the knowledge they have learned (Tang and Hew 2017).

Guideline Development

Based on these gaps and the considerations about Interaction Theory, as well as the practical requirements identified by the survey and the workshop, we developed five guidelines to improve the design of interaction videos in order to enhance the interaction possibilities in the videos and to close the identified gaps. Due to the wide range and design possibilities of learning videos, the guidelines refer in particular to the short learning videos, which are recommended by Brame (2016). He recommends the use of short 3- to 6-minute

videos in order to keep the engagement of the students as high as possible and also to address a specific learning goal within the video.

Learner-Content Interaction: Especially the missing presentation of learning goals is a problem for many learners when using learning videos. Although the learning objectives of the educational video are presented at the beginning of the video, about one third of the students in the study told us that they were unsure about the objectives of the video. Against this background, interaction elements should be used where the learning goals are addressed in the learning video. In this way, we give the learners the opportunity to stop at these points and to better understand what is being said. This can foster the reflective ability of learners (Oeste-Reiss et al. 2016) and can help to scaffold their learning process (Sun et al. 2018) (Guideline 1). Structuring elements such as crossroads, which mark important areas in the video for the learner, are particularly suitable as interaction elements. Due to the lack of interaction in the learning video, it is often difficult to assess whether the learner has understood the learning content or not. Such obligatory learning progress checks, which are made possible by question types such as multiple-choice questions or drag-and-drop elements, should rather be used at the end of the learning video so that the flow of learning is not unnecessarily disturbed. (Guideline 2). Moreover, the learner should be able to check whether they have understood the content shown. These voluntary learning progress checks can be made possible in a targeted manner through various interaction elements and can be offered throughout the entire learning video, as these must be actively clicked on by the learners and do not automatically stop the video. These checks serve as self-assessment for the learner and, thus, offer students the opportunity to critically reflect on their learning process. Furthermore, it prevents mind-wandering thoughts because the learner has to continuously deal with the content (Schacter and Szpunar 2015), without interrupting their learning process actively. (Guideline 3).

Learner-Learner Interaction: Reflection on learning necessitates exchange between learners. As Coetzee et al. (2015) mentioned, even a short interaction between learners can improve the learning performance. Through the use of recurring images that ask learners to act in a certain way or links to external sources such as forums or chats, interaction can be encouraged by the video. In order to enhance the interaction between learners, the instructor must design the learning video in such a way that the students are encouraged to interact with each other (Guideline 4).

Table 3. Reference Guidelines for the Design of Interactive Videos		
Interaction Type	Guideline	Explanation
Learner – Content	Guideline 1: Learning Objectives	Use the learning objectives to determine the positions of the interactive elements by adding interactive elements in the places where the learning objectives are addressed in the video (Gap #1 & #2).
	Guideline 2: Learning Controls	Use learning controls at the end of the video to verify that the content has been understood (Gap #2 & #3).
	Guideline 3: Voluntary assessment	Use elements of interaction from the beginning so that learners can voluntarily delve deeper into the subject and monitor their learning progress (Gap #2 & #3).
Learner – Learner	Guideline 4: Promoting Exchanges	Think about where a task to interact with other students is useful and necessary and add elements at this point that invite students to interact with each other (Gap #4).
Learner – Instructor	Guideline 5: Feedback Elements	Offer the possibility to get feedback after each interaction element (Gap #5)

Table 3. Reference Guidelines for the Design of Interactive Videos

Learner-Instructor Interaction: Especially in complex learning situations, it is important to support students in the learning process. Due to the lack of interaction possibilities in videos, problems of learners can only be recognized very late. At the same time, many students find it difficult to formulate their problems in such a way that the teacher can understand the problem without reference to the learning material. Therefore, the interaction elements should be placed in such a manner that they provide quick feedback for the learner (Guideline 5).

Experimental Design of the Planned Evaluation

In order to evaluate our developed reference guidelines, we plan a holistic evaluation consisting of two parts. Firstly, we want to examine whether the developed reference guidelines can help to improve the interaction between learners, thereby improving the motivation and learning success of learners as we describe it in our research model (see Figure 1). Second, we want to investigate the influence of different element variations described in the guidelines on these core aspects such as learning outcomes or motivation. For the evaluation, it is planned to conduct between-subject 2x2 full-factorial experiments among students in a business informatics course. The participants will be randomly assigned to one of the groups. The short interactive learning videos will be designed by the research team following the presented guidelines. In the first experiment, we want to check whether or not the learning controls interrupt learners in their learning process and if they help the students to structure their learning process. The first group works with videos, which include both voluntary assessments (Guideline 3) and learning controls at the end of the video (Guideline 2). The second group works with the same video including just the mandatory learning controls at the end of the video. Group 3 works with videos with voluntary assessments and group 4 is our control group. The time frame for viewing the videos is predefined. However, the participants are given enough time to stop or fast-forward and rewind the videos on their own to ensure that the conditions between the groups is as equal as possible. A pretest will be designed in such a way that we can assess the previous knowledge of the learners (Gupta 2013) as well as the cognitive load (Korbach et al. 2018). In the posttest, we will assess the knowledge acquisition (Gupta 2013), the cognitive load (Korbach et al. 2018) as well as the motivation of the learner (Li and Keller 2018). The following experiments will focus on other aspects of the guidelines. The aim of this division into several experiments is to get an exact view of the different aspects of the interactive learning videos. Following our DSR approach, we use a Human Risk & Effectiveness (Venable et al. 2016) approach according to the FEDS framework to evaluate our reference guidelines. In particular, we are evaluating whether the use of the guidelines has reduced the cognitive load and improved the interaction of the learners. Hence, we will measure the motivation (Li and Keller 2018) and the learning success (Gupta 2013) of learners because an improvement of interaction leads to better motivation and learning success of learners (Schneider et al. 2020).

Expected Contribution and Outlook

The expected contribution of our research is twofold: On the one hand, we offer a theory of design and action according to Gregor (2006) and thus a new solution to enhance the interaction of learners when using learning videos. We make a theoretical contribution by systematically developing theoretically driven requirements and identify three problems in the design process of interactive learning videos. This gives us a deep understanding of how such interactive learning videos must be designed to support the learning process. Thus, we offer practitioners concrete guidelines to develop interactive learning videos for different courses that enhance the interaction of learners to increase motivation and learning success. With the results of this research-in-progress paper, the first considerations regarding the design of the interactive learning videos are completed. After the videos are developed, the demonstration and evaluation phase of our DSR approach begins to present completed research.

Acknowledgements

The research presented in this paper was funded by the German Federal Ministry of Education and Research in the context of the project KoLeArn (www.KoLeArn.de), Grant No. 01BE17008A.

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