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MATHEMATICS VIDEO PODCASTS AS INTEGRATED ELEMENTS OF ONLINE LESSONS IN FURTHER UNIVERSITY EDUCATION: IN-SERVICE TEACHERS' FLOW EXPERIENCES

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Abstract: *This case-study examined in-service teachers' perceptions of learning by means of online mathematics lessons consisting of a mix of text and video podcasts. The investigation is part of further university education directed at practicing teachers in lower secondary schools. The course was a distant education course, with in-service teachers learning online only. The research, based on a series of questionnaires and follow-up interviews, examined whether in-service teachers perceived that video podcasts embedded in online lessons fostered their learning compared to reading similar material. The study focused on efficiency, enjoyment, and concentration as perceived conditions for learning in conjunction with flow theory.*

Keywords: design principles, distance education, flow theory, video podcasts

Introduction

The case study is part of a research and development project aimed at offering video podcasts with mathematics education and mathematics academic content. Subjects were in-service teachers of a further university mathematics education program for teachers in lower secondary schools. The program was offered to teachers who might not otherwise have the opportunity to engage in education on campus.

Video podcasts were integrated in multimodal online lessons where the majority of text was used to reinforce subject content rather than provide a complete presentation of material. Podcasts were recorded and edited with screencasting software, and designed upon research-based principles and recommendations consistent with how the human mind works, as well as, presentation of stimulating and emotionally compelling information.

Encouraged by in-service teachers' positive feedback (Brodahl & Wathne, 2016) claiming that learning with video podcasts is better than learning from text only, and that they wanted more of this type of instruction, the goal of this paper was to investigate why efficiency, enjoyment, and concentration were perceived to be central conditions for learning mathematics through integrated video podcasts in online lessons. The paper is structured as follows. First, the research questions are presented. Second, the theoretical framework is described and a literature review provided. Third, the methodology is explained. Then, the results are presented, analyzed, discussed, with future directions proposed.

Research Questions

This work examined in-service teachers' perceptions of learning by means of online lessons where text and video podcasts were the main carriers of educational content. The videos were developed following research-based instructional design principles and models. The investigation is

part of a university continuing education program directed towards students who already work as teachers. The course was delivered entirely online, and in-service teachers, enrolled as students, learn fully online at a distance.

The purpose of this study was to address participants' learning with video podcasts as integrated parts of online lessons, and to identify the video elements that they perceived fostered learning. Accordingly, two specific research questions were addressed:

- 1) What conditions for learning are crucial for in-service teachers' experiences with video podcasts as integrated parts of online lessons?
- 2) What roles do these conditions play in-service teachers' perceptions of the learning process and learning outcome?

Theoretical Framework and Literature Review

The use of instructional videos is gaining ground in university level courses. While the study of the efficacy and effectiveness of video podcast is still in its infancy, with results of some scientific studies seemingly inconsistent, there also is evidence of their effectiveness within different domains including mathematics (Fernandez, Sallan, & Simo, 2015), and among different learners including in-service teachers (e.g., Brodahl & Wathne, 2016; Hsin & Cigas, 2013; Kay & Kletskin, 2012; Lloyd & Robertson, 2012; Loch, Gill, & Croft, 2012) that warrant optimism. The theoretical framework for this study was drawn mainly from cognitive theory of multimedia learning and flow theory in instructional design, with implications for the use of video podcasts as educational tools drawn from each theory.

Cognitive Design Principles. How can video podcasts be optimized to allow for deeper learning? Information first enters

the learners' cognitive processing system through the two senses of sight and sound, and then enters working memory where only a limited amount of information can be stored and handled at one time. Mayer (2001) established the cognitive theory of multimedia learning (CTML). CTML is an evidence-based theoretical framework explaining how multimedia benefits learners that is based in classical research of human memory (e.g., Baddeley & Hitch, 1974; Miller, 1956) and dual coding (Paivio, 1986). Mayer's research examined boundary conditions of multimedia learning and found that the use of two or more modalities (e.g., text, image, sound) is better than the use of one, but can become ineffective if the instructional design includes redundant or transient materials, or splits learners' attention. The use of two or more modalities also may be ineffective when learners possess high levels of prior knowledge.

CTML research established design guidelines for educationally effective multimedia materials, including providing coherent verbal and pictorial information, guiding the learners to select relevant words and images, and reducing the load for a single processing channel (Mayer, 2014). Furthermore, having learners produce oral explanations in their own words concurrently while viewing images is superior to viewing images with an accompanying text explanation (Mayer, 2014). CTML principles about how to reduce extraneous processing, manage essential processing, and foster generative processing are research-based and provide guidance about how to design multimedia messages consistently with how the human mind works.

Flow Experience. Efficiency, enjoyment, and concentration are perceived as central conditions of learning with video podcasts during online lessons (Brodahl & Wathne, 2016). These also are important elements within flow theory (Csikszentmihalyi,

1990), where flow is defined as a state of consciousness experienced by people involved in an enjoyable activity. While the factors and measurement of flow used in specific empirical studies differ, they can be divided into four categories (Ho & Kuo, 2010). The first, autonomy, includes a sense of control; the second, concentration, comprises concentration on the goals and tasks at hand; the third, stimuli, includes curiosity and extrinsic enjoyment; and the fourth, genuine motivators, embraces task interest and intrinsic enjoyment in accordance with task importance. Furthermore, flow defines a difference measure between skill and challenge. Hence, researchers consider a good flow experience to be based on a balanced ratio of these factors (Csikszentmihalyi, 1990). This balance is considered to work in a positive way for individuals in carrying out target tasks (Shin, 2006).

Of the various models and measures of flow experiences proposed in the literature, this study adapts Trevino and Webster's (1992) classification using four factors, which correspond with Ho and Kuo's (2010) categories of feeling in control (autonomy), focusing attention on activity (concentration), feeling curiosity (stimuli), and having intrinsic interest (genuine motivators) with feelings of efficiency and intrinsic enjoyment included in the latter. The term flow as used in this paper refers to a certain positive experience that in-service teachers may have while engaging in online lessons that consist of a mix of text and video podcasts (Shin, 2006).

Methodology

Case Study

This case study explored in-service teachers' perceptions of mathematic video podcasts in a higher and distant education setting. It included a community of in-service teachers from across the country,

incorporated in a national program of further university mathematics education directed towards practicing teachers. The study was based on two research questions and used quantitative data from questionnaires and qualitative data from interviews conducted in the second semester of the study program.

As Anderson (2011) cautioned, any study of the impact of podcasting on learning should start with the design of high-quality podcasts. Accordingly, this study included the successive production of 46 podcasts, guided by 10 features:

- Video clips were kept at a minimal length, usually lasting no longer than 15 minutes.
- Visuals and animations were used with synchronized narration.
- Layout and dynamics were spatially planned and organized.
- Narration was relaxed, relatively fast paced, and dialect unspecific.
- Learners were addressed in a personal and conversational style, with energy and enthusiasm.
- Learners' attention was guided visually to important elements and content relations.
- Context was explained and connected to previous mathematical knowledge and key concepts.
- Content was weeded and unnecessary information eliminated.
- Content was presented in a step-by-step fashion, with key elements explained briefly.
- Captures were post-edited and audio-visual distractions removed.

These features were based on research-based principles for effective multimedia design, with most of them drawn from the CTML framework (Mayer, 2014). Other features were derived from non-cognitive considerations about how to make instructional videos more sensorially and emotionally interesting (e.g., Guo, Kim, & Rubin, 2014; Hibbert, 2014). These

features are described in more detail in a prior study conducted in the first semester of the study program (Brodahl & Wathne, 2016), with findings from this prior study informing the development of high quality video podcasts.

Videos were recorded using the screencasting software *Camtasia* and media-rich *PowerPoint* slides, with recordings edited before uploading on a course web page. Each podcast was developed as stand-alone instruction, created for and implemented into a particular online lesson, and accompanied with a PDF-copy of the *PowerPoint* slideshow.

The research was conducted in two steps. First, in-service teachers were asked to rate samples of videos, reflecting on how studying each video fostered their learning compared to reading similar material. Questionnaires were based on the responses given in the first semester (Brodahl & Wathne, 2016). Second, in-service teachers were interviewed. The interviews drew on in-service teachers' responses to the questionnaires.

Participants

The analysis included data from 14 in-service teachers (7 males and 7 females), over the course of half an academic year (2014). The participants were teachers (mainly from grades 8-10), and all had teaching certificates. Participants were enrolled in *Calculus (15 ECTS)* as the second part of a one-year mathematics course, delivered entirely online. Their ages ranged from 26.8 to 56.1 years ($M=42.2$ years).

Setting

The online environment for the course was considered the setting for the investigation. The course was delivered using the university's learning management system

[LMS], *Frontier*. Content and activities were presented through online lessons, with each online lesson provided as a multimedia module. Each module included an introduction, table of contents, learning goals, and chapters about different topics in the subject area. A digital text-video format (Engebretsen, 2006) was chosen with clickable video thumbnails integrated into the body of the text in a tabloid fashion. Chapters included tasks and exercises, quizzes and surveys created in the LMS test tool, and links to external resources.

Data Collection

The study used questionnaires and interviews for data collection. A series of seven weekly questionnaires were conducted, each of which assessed a subset of videos (usually one of two) from the current lesson. Four statements reflecting the research questions were posed for each sample video. Respondents were asked to indicate their level of agreement by selecting the category on a seven-point Likert scale that best represented their experience with the video (i.e., Strongly Agree, Agree, Slightly Agree, Neither Agree nor Disagree, Slightly Disagree, Disagree, Strongly Disagree). Statements regarded participants' perceived efficiency, enjoyment, concentration, and learning outcomes respectively.

Survey participation was voluntary and by informed consent. Responses were not anonymous in order to facilitate follow up interviews. However, responses were anonymized after final data collection. The LMS test module was used for collecting and processing responses.

Semi-structured interviews were chosen as the primary source of data for this study, since conditions for learning identified in the questionnaires were not directly observable. The interview focus involved in-service teachers' perceptions about the

roles of these conditions. The interviews were intended to clarify and gain further insights about participants' questionnaire responses. The participants received the interview guide prior to the interviews. It detailed 20 questions, half of them taking the form of statements (e.g., "In the questionnaire, you answered...") seeking in-service teachers' explanations for their answers. The main focus of the questions involved perceived efficiency, enjoyment and concentration, and learning outcomes related to using video podcasts. Other questions concerned the intensity and use of video podcast use, the role of video podcasts in the lessons, and perceived benefits of the video podcasts.

Participants who engaged in the voluntary interviews consisted of two males and three females of varying ages (38-56 years) who resided in different parts of the country. Interviews were conducted by phone midway through the second semester. Informed consent was obtained and permission for audio-recording granted at the beginning of the interviews before collecting information. The interviews lasted about 15-22 minutes and were transcribed and anonymized. Questionnaires were written in Norwegian and the interviews were conducted in Norwegian. All questionnaire statements and interview comments presented here are the authors' translation or paraphrasing.

Data Analysis

Fixed-choice responses in questionnaires were exported to and organized in

Microsoft Excel. Interview transcriptions were coded, mainly guided by the research questions and questionnaires themes. Coding included identifying and classifying statements concerning the video podcast, in-service teachers' work modes and tasks, the process of learning by means of integrated video podcasts, and perceived learning outcomes, and recommendations. These organized lists were exported to *Google Drive* for further formatting, reading, and analysis.

Data from interviews were analyzed using a content analysis approach (Mayring, 2014). The researchers transcribed each recording by converting it to text data. Both researchers first performed data analysis independently, familiarizing themselves with the data. In an iterative process, themes and codes were identified and labeled using inductive and deductive approaches (Bryman, 2012). The researchers then exchanged codes and organized them in a coding structure, establishing a set of codes with themes and subthemes. Independently coding and recoding the data set, they compared and discussed coding until consensus was established.

Figure 1 illustrates the research framework of this study. Drawing on Shin's (2006) conceptual model of online learners' flow experience, it posits efficiency, enjoyment and concentration as central flow experiences of online video podcast learning, with learning outcomes perceived to be a consequence of flow.

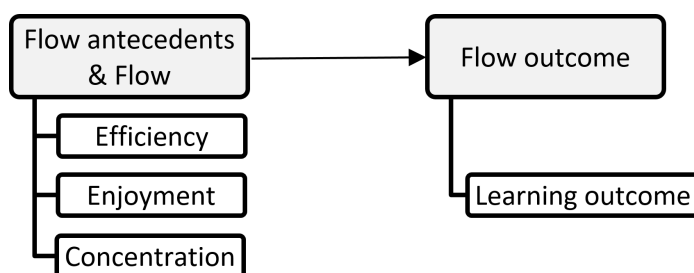


Figure 1. Online learner's flow experience.

Results

The results of the study were examined in two separate sections: questionnaires and interviews.

Questionnaires

The following statements were posed for 20 of the 46 videos offered during the course:

1. I am more concentrated watching a video like this as compared to reading similar material.
2. I enjoy watching a video like this more as compared to reading similar material.
3. I perceive more efficient use of time watching a video like this as compared to reading similar material.

4. I perceive better learning outcomes watching a video like this as compared to reading similar material.

The 14 participants provided responses for 20 sample videos, returning 238 fulfilled questionnaires. Hence the average response rate for each of the samples was 85%. Among those responding, 90.8% agreed that they were more concentrated when watching videos than when reading, 91.6% enjoyed watching videos more than reading similar materials, 90.3% perceived video podcasts to be a more efficient use of time versus reading materials, and 91.2% indicated that they experienced better learning outcomes when watching videos than when reading (Table 1).

Table 1
Participants' Perceptions of Watching Video Podcasts

Statement	Responses N=238									
	SA	A	SLA	N	SLD	D	SD	TA	TD	
Efficiency	95 <i>(39.9)</i>	90 <i>(37.8)</i>	30 <i>(12.6)</i>	19 <i>(8.0)</i>	3 <i>(1.3)</i>	1 <i>(0.4)</i>	0 <i>(0.0)</i>	215 <i>(90.3)</i>	4 <i>(1.7)</i>	
Enjoyment	93 <i>(39.1)</i>	96 <i>(40.3)</i>	29 <i>(12.2)</i>	18 <i>(7.6)</i>	2 <i>(0.8)</i>	0 <i>(0.0)</i>	0 <i>(0.0)</i>	218 <i>(91.6)</i>	2 <i>(0.8)</i>	
Concentration	90 <i>(37.8)</i>	102 <i>(42.9)</i>	24 <i>(10.1)</i>	18 <i>(7.6)</i>	1 <i>(0.4)</i>	2 <i>(0.8)</i>	1 <i>(0.4)</i>	216 <i>(90.8)</i>	4 <i>(1.7)</i>	
Learning Outcome	95 <i>(39.9)</i>	91 <i>(38.2)</i>	31 <i>(13.0)</i>	20 <i>(8.4)</i>	1 <i>(0.4)</i>	0 <i>(0.0)</i>	0 <i>(0.0)</i>	217 <i>(91.2)</i>	1 <i>(0.4)</i>	

Note. Response frequencies in bold, percentages italicized and parenthesized.

Key for Table 1: Strongly Agree (SA); Agree (A); Slightly Agree (SLA); Neither Agree or Disagree (N); Slightly Disagree (SD); Disagree (D); Strongly Disagree (SD); Total Agreement (TA); Total Disagreement (TD)

With regards to the length of a clip, in-service teachers' perceptions of efficiency, enjoyment, concentration, and learning outcome did not appear to differ substantially between short videos (1-5 mins) and moderately long videos (6-15 mins), with a slightly higher rating for moderately long videos. The only video classified as long (16:48 mins) received the

highest rating, with 92.3% agreement on concentration, 92.3% agreement on enjoyment, 100.0% agreement on efficiency, and 92.3% agreement on learning outcome.

Interviews

Interviewing five in-service teachers individually, the authors asked participants

to explain their reasons for strongly agreeing with statements as presented in the questionnaires. Participants' comments pointed to five factors (Table 2) that lead to video resources being preferred to reading materials: efficiency with respect to learning; enjoyment with respect to presentation format; concentration with

respect to the opportunity to use several senses; sense of control with respect to receiving explanations through multiple modalities and/or step-by-step narration. The most frequent comment was about subject content which referred to the precise presentation and explanation of mathematics or mathematic didactics.

Table 2
Factors Affecting Learning When Watching Instructional Videos

Factors	Sample Comments
Efficiency	It is faster to watch a video than read a text. You can follow the reasoning faster in a video. The videos streamline the entire training.
Enjoyment	Learning from video is simply nice...I am enjoying it. It's really fun to learn new subject matters that way. I think it was absolutely wonderful to hear southern intonation. I have enjoyed the videos very much, because they used animation, colours and arrows, and you've read at a decent pace, and they are short.
Concentration	A video makes me focus and forces me to pay attention all the time; otherwise I would miss out on something important. I have to hear, see and do. It sharpens all senses. I have to use multiple senses. I have to see, hear and energize all of me when watching a video. The explanations are given in both visual and auditory forms.
Control	I feel I have more control over what I should learn...[and] that what is shown is learned. I remember better when I see and hear. The step by step process in particular; having seen how to makes it much easier to practice.
Subject content	The main content is extracted and the substance more condensed in videos. [In a video] the job of picking out the most important subject content is [largely] done. [They] picked up the very essence, so reasoning gets easier for me. A precise explanation of the theory and substance. A video is often more specific on exactly that which I am wondering about.

When asked other questions about the characteristics of good video podcasts within online lessons, or how video podcasts contribute to lessons, in-service

teachers referred to their learning process as illustrated in sample comments below:

Efficiency: [A video] makes it easier to see connections and relations [in mathematical problems].

Enjoyment: The videos help make it fresh.

Concentration: [Videos should] make me focus....and force me to pay attention.

Control: A video helps to make things varied, and explains in a simple and straightforward way, making challenges smaller and problems easier to figure out.

Subject content: You get extra explanation on video. The videos explain further.

The in-service teachers expressed that videos provided a feeling of flow in their learning:

Watching a video energizes all of me....[as] explanations given [are] both visual and audible.

[Learning from video] is simply nice. It gives a feeling of attending a live lecture and having more control....[The] most important issues are extracted and [the videos] are very clear on what the objective is.... It makes learning fun and, in this way, facilitates learning.

Participants also commented that the use of videos made learning easier and helped in solving many of the (tasks and) math problems that they encountered. In this way, the interviewees related to learning outcomes directly as consequences of using videos as illustrated in sample comments below:

The videos streamline the entire learning process. It is far easier to learn new and partly difficult material.

A video offers several approaches to the subject matter. You are given several different approaches to the subject matter.

Variation in the presentations is useful. You remember better what is new, surprising, or different.

Discussion and Conclusions

Learning Conditions

Responses from the questionnaires suggest that flow experiences related to videos as vehicles for instruction. In-service teachers rated efficiency, enjoyment, and concentration highly for their learning processes (averaging Agree or Strongly Agree on a Likert scale). These results are in line with comments from the interviews.

In-service teachers perceived efficiency as the degree to which the presentation is efficient with respect to improving learning: "It is faster to watch a video than read a text," "You can follow the reasoning faster in a video," and "The videos streamline the entire learning process." In-service teachers perceived enjoyment as a pleasant feeling associated with watching a video podcast: "[Learning from video is] simply nice ... I am enjoying it," and "It's really fun to learn new subject matters that way." The video format is perceived to be enjoyable.

In-service teachers perceived concentration as maintaining focus on the video podcast: "A video makes me focus and forces me to pay attention all the time; otherwise I would miss out on something important." Concentration involved keeping the learners' focus on what was presented and eliminating distractions. In addition, in-service teachers appreciated that educational podcasts provided them with a sense of control through the inclusion of step-by-step, extensive, and easy-to-follow explanations, which made the podcasts flow-inducing.

In-service teachers' perception of efficiency, enjoyment, concentration, and control are consistent with some of the core characteristics of flow experience. Flow is a state of consciousness that is experienced by people who are deeply

involved in an enjoyable activity (Csikszentmihalyi, 1990). As such, there are signs of flow experience in the data, with participants reporting a state of consciousness with high concentration and involvement, clarity of goals, and intrinsic motivation. Whilst participants in this study appreciated videos as contributing to variety in content presentation, and as reassuring and clarifying learning goals, content characteristics are not largely addressed as antecedents of flow in the literature (Hoffman & Novak, 2009).

Learning Process & Learning Outcome

High questionnaire ratings for perceived learning outcome related to video podcasts is consistent with interview comments. The in-service teachers indicated that they kept their concentration and felt a sense of control over their learning process. Valuing step-by-step, extensive, and easy-to-follow explanations as part of video presentations is consistent with the literature (Kay, 2014).

The in-service teachers actually used the video podcasts and appreciated their use of multiple senses, “I remember better when I see and hear.” For this in-service teacher, visual and auditory aids were perceived as helpful. This belief is consistent with the multimedia principle (Mayer, 2014) that learning is improved with the use of words (spoken or written) and pictures versus words alone. Notably, the in-service teacher pointed out benefits of underlying design choices without being asked to do so. The contiguity principle (Mayer, 2014) proposes that the use of graphic information promotes interpretation processes, consistent with one participant’s statement: “I have enjoyed the videos very much, because they used animation, colors and arrows, and [the narrator has talked] at a decent pace, while they are short.” Moreover, the modality principle (Mayer, 2014) suggests that increased learning may occur with the addition of audio material to

text and is perceived to be important for in-service teachers’ learning processes. In addition, in-service teachers preferred videos to be kept to minimal possible length depending on their content, consistent with previous studies (e.g., Bergqvist, 2013; Guo, Kim, & Rubin, 2014).

Participants’ interview responses also support Mayer’s signaling principle, indicating that learning material should be organized with clear outlines and headings (“I prefer that it says in the beginning what the lecture is about,” “[The videos] are very clear about what the objectives are”), and the personalization principle indicating that conversational style is preferred to formal style (e.g., “I think it was absolutely wonderful to hear southern intonation”). Further, personalization and empathy may have triggered one in-service teacher’s perception of, “feeling that you are in contact with the teacher, by means of the videos.”

It also appears that the subject content in the video podcasts plays a major role in the in-service teachers’ perceptions of the learning process and outcome. In-service teachers appreciated the video podcasts because, “[They] picked up the very essence, so reasoning gets easier for me,” and “[In a video] the job of picking out the most important subject content is [largely] done.” These results are consistent with previous research on content weeding (e.g., Ibrahim, Antonenko, Greenwood, & Wheeler, 2012; Mayer & Moreno, 2003). Also, in-service teachers emphasized that the videos contributed to content. For example, one participant commented: “A precise explanation of the theory and substance,” which indicates that in-service teachers are sensitive to how the mathematical content is presented consistent with Bergqvist (2013).

The main purpose of this study was to address in-service teachers’ learning with

video podcasts as integrated parts of online lessons, and to identify why they perceive the videos to foster learning. In-service teachers perceived efficiency, enjoyment, and concentration as main conditions in their learning process. They spontaneously pointed out benefits of underlying design choices (e.g., use of multiple sensory modalities including graphic and audio information, length of the video podcasts). In-service teachers appreciated the video podcast format, and, the data indicates that the video subject content played a role in participants' perceptions of learning process and learning outcome.

The limitations of the work are associated around four issues: sample, reliability, validity, and time considerations. First, the study was conducted with a small convenience sample, with participants from one class only. While this does not invalidate the results, readers need to consider that replication studies with a larger population may confirm or question these research results. Similarities between our findings and previous studies (e.g., Andersen, 2011; Shin, 2006), support some degree of generalizability. Second, reliability is enhanced by a detailed description of population characteristics and research methodology, allowing for

the replication of the study. Third, quantitative survey questionnaires alone cannot accurately measure in-service teachers' perceptions of podcasts, with a higher degree of measurement validity gained through the triangulation of survey questionnaires and qualitative interviews. The fourth limitation is concerned with the respondents describing flow retrospectively versus during, or immediately after, video watching, which may have resulted in less accurate recall of their experiences.

Future Work

This study considered indicators of flow experience associated with perceived impact on the learning process and learning outcomes. Suggestions for future research on using mathematics video podcasts integrated into online lessons may include additional investigation of in-service teachers' experiences of control as emphasized by the interviewees who participated in this study. Finally, undertaking interviews immediately after in-service teachers engage with a lesson and complete a questionnaire may be considered as a means for reducing limitations associated with this work.

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