

Effect of Video Presentation on Content Understanding in Online Courses

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ABSTRACT

Recently, the corona pandemic has forced educational institutions to transform lectures and courses into an online format using different media such as online tutorials or videos also increasing the need for good online presence. Previous work mainly compared the effect of videos and live lectures on student learning or examined additional factors like the playback speed while there is only few research considering the presentation form itself. To find out if there are any differences in content understanding we conducted two studies: an online survey among university teachers asking about their current style of video presentations and a user study with university students to compare the different video presentations with each other. Participants watched the three presentation forms: slides with voice-over, talking head and picture-in-picture created by a university lecturer and answered an exam containing fill-in-the-blank, multiple choice and free text questions about the content of the video. Even though we could not find any significant difference, the presentation form talking head had the lowest average percentage of correct answered questions across two different learning video topics. This could imply that the presence of slides in online lectures leads to better content understanding.

KEYWORDS

e-learning, video, content, presentation, corona, remote, online, courses

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1 INTRODUCTION

As a result of the current Covid-19 pandemic, educational institutions have to transform their courses, tutorials or meetings into an online format or hold their lectures via live stream to avoid direct contact [13, 14]. The concept of e-learning describes a teaching and learning approach based on electronic media and devices to improve access to training, communication, interaction and to facilitate the

introduction of new methods for understanding and developing learning [15]. One such technical opportunity are online courses.

Online courses or online lectures are usually structured into several sequences and, in addition to the lecturer's videos, contain resources such as assessment problems or interactive demos [6]. These videos normally present visual content an instructor creates in advance to complement their online courses or live performances or, as in the present case, to replace live lectures due to the corona pandemic. They have the same content and context as the lectures in face-to-face form but can be accessed from anywhere without being physically present. Conventionally they consist of the lecturers' slides and their audio recordings [4].

However, learning videos can be presented in different ways. Common presentation styles include *classroom lectures* showing the lecturer plus blackboard, *talking head* style where only the instructor can be seen, *Khan-style* which is presenting a digital tablet drawing format or *slides* such as PowerPoint presentations [6]. In particular, learning content should be designed so that students can easily understand them. Rapanta et al. [14] gathered the challenges lecturers have to face when providing online activities during the pandemic by interviewing several experts. According to them the success of online courses is based on the learning design, teachers' presence and assessment.

To correctly convey the learning content to the students, lectures have to ensure to meet these requirements. Since videos offer one such opportunity, it is necessary to know which factors are influencing content understanding in online courses. A distinction can be made between technological and content-related factors. For this purpose, we divided this topic into two groups: group A dealt with quality differences in audio and video while we, group B, focused on the different presentation styles. We wanted to know if there is any difference in content understanding considering the presentation form and if this is the case what impact these styles have on student learning.

To this end, we assumed that there is a significant difference in content understanding between the three video presentation forms: slides, talking head and picture-in-picture. Several studies have already been conducted to study the usage of different video presentations considering the influence of common styles such as Khan-style or talking head on students' engagement, cognitive load and learning [6–8]. Nevertheless, the reasons for the selection of the styles have not been explained so far.

For these reasons, we conducted two studies investigating which styles are mostly used and what effect they have on content understanding. Findings can be of interest to any lecturer who wants to improve their online teaching. To optimize the learning quality,

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they can adapt their video presentation style. This means that the students in particular benefit from the adjustments to the videos.

We structured our paper as follows. First, we present the previous work focusing on online teaching and the use of videos. After that, we describe a preliminary survey investigating how instructors at the University of Regensburg currently design their videos and live lectures for online learning. Subsequently, we present our main study where we used the results from the survey to create different types of video presentations. With these, we examined the influence of different video presentation forms on content understanding.

2 RELATED WORK

The number of present studies considering videos and online teaching shows that the use of videos has already been a demanding research area. Previous work concentrated on the effect of videos on learning or students' perception emphasizing the difference between video and live performance as well. It was examined how videos could replace the live lecture if participants either had both options available or were randomly assigned to one variant. Furthermore, various kinds of videos were compared with each other. To this end, several factors such as interactivity, speed and various design elements were discussed as well as different learning situations. Since we focus on this area, we also have a brief look at them highlighting what we want to do differently.

2.1 Learning with Videos

One big area of interest focused on the impact learning videos have on students while also comparing live lecture and video with each other. Draus et al. [5] investigated how instructor-generated video content effects student satisfaction, engagement, and performance. They created several videos such as instructions and discussion postings which were compared with three sections that did not get any videos. They revealed that students perceived high value in using the videos, grades became better and the number and length of student discussion postings increased. Cardall et al. [2] conducted a survey asking their students about their perceptions, evaluations, and motivations concerning live lectures and compared them with accelerated video lectures. They found that most students think that they can increase their knowledge acquisition, look for more information, stay concentrated and learn more with the recorded lecture.

Another comparative study was conducted by Schreiber et al. [17] They investigated information recall, student experience and preference of their students after watching the live lecture or a video podcast. They randomized the students each to the live lecture or the video and switched groups after seeing the lecture and answering a multiple-choice questionnaire. There was no significant result, but students mentioned that it was suitable to stop, review and repeat the video. Nevertheless, they preferred the live lecture. The influence of the lectures style on memory, wandering of thoughts and the subjective factors of interest and motivation was examined by Varao-Sousa and Kingstone [18]. All students received one live version and one video recording of the lecture. Results show that the lecture format can affect memory performance while students achieved better results after watching the live sessions. They also

reported to be more motivated and have a greater interest when watching the live lecture where the professor was present.

Schnee et al. [16] compared the performance of pharmacy students who visited the live session with students that were absent and viewed the videos later. They found that students who visited the live lecture were associated with better performance on the exam than students that were only seeing the videos. Similar findings were achieved by Williams, Birch and Hancock [19] who explored the effects of lecture attendance and online lecture recordings. Their findings revealed that students using the online lectures instead of visiting the live lecture were clearly worse considering their final grade and also did not get any improvements by watching more videos. However, students who were present at most live lectures benefit from using the recordings as a supplement. Another comparative study was conducted by Kestin et al. [9] who randomly assigned students to a live demo or a video version. Their results show that students watching the video demo learned more and stated to enjoy it equally. Therefore, they conclude that it could be beneficial to supplement live demonstrations with videos.

2.2 Comparing Learning Videos

As we are focusing on the style of video content, we also kept in mind previous work that concentrated on differences in presentation. To this end, Cross et al. [3] focused on the display of text in videos. They compared handwritten recordings of the lecturer with the typical PowerPoint presentation and invented a hybrid form for text presentation that transforms handwritten text into typeface after a short time. Lang et al. [11] explored the relationship between the playback speed of a video and students' grades. The videos were played either 1.0x or 1.25x speed resulting in better grades for students with the sped-up version.

Zhang et al. [20] examined the impact of interactive video on learning while comparing e-learning environments with interactive, non-interactive and without video with the common classroom environment. Also, Moos and Bonde [12] explored the effectiveness of embedded self-regulated learning (SRL) prompts comparing videos with and without SRL and measuring prior knowledge, SRL and learning outcomes on a different learning approach called the flipped classroom. The inverted classroom describes a concept where things that are normally done in class are now done at home and vice versa which means that the learning content is taught per video and teachers take a tutorial role by practicing the knowledge the students gained from the videos. Students can control the pacing and sequencing of information on their own [1].

Another study conducted by Brecht [4] aimed to search for learning benefits of video lectures, to measure the acceptance and usage of them and to specify if learning is affected in different ways using alternative designs as well. They compared three designs. Design 1 did not contain any relief and change-of-pace elements, design 2 had visual as well as auditory elements and design 3 placed similar elements more subtle. Findings show that design 2 achieved the best results considering learning, they are used for tutorial help, enhance initial learning, decrease dropout rates, and improve grades.

Investigating the effect of video presentation designs in supporting teaching Ilioudi et al. [8] compared the two different styles talking head and Khan-style with each other. Using the talking

head style, the videos contained the lecturer inclusive the traditional green chalkboard and Khan-style the interactive drawing board with voice over. Additionally, there was a control group that studied through a paper-book. Overall, the talking head style was more efficient for complex topics than the paper-book.

Guo et al. [6] conducted a large-scale study examining how video production style affects students' engagement. They measured engagement by looking how long students were viewing each video and if they tried to answer post-video assessment problems. The study included the presentation forms slides, code, Khan-style, classroom, studio, and office desk while most videos were labelled with several presentation styles. Considering the presentation style their findings show that the lecture needs to be visible, informal settings could be more engaging and Khan-style is better than the simple PowerPoint.

Homer et al. [7] investigated the effect of video on cognitive load, social presence and learning in multimedia learning environments comparing a video of the lecture including synchronized slides with a video containing only slides and an audio recording of the lecture within two studies. First, participants watched one of the two video versions followed by measures of learning, cognitive load, and social presence. In the second study, students were randomly assigned to one of the video versions answering the same questionnaires. Additionally, they were asked about their background knowledge and if they prefer visual or verbal learning. Both studies revealed that there was only a significant difference for cognitive load concerning the presence of the lecturer or visual preference.

2.3 Summary

Overall, most research confirmed that videos could be a useful medium for online teaching providing several advantages live lectures do not have like controlling the speed or promoting student engagement. Furthermore, students can benefit from videos in different situations such as replacing or supplementing the regular live lecture or in the inverted classroom. However, currently videos need to replace the whole live section and therefore have to convey the learning content as good as possible.

Although previous work investigated the influence of video on learning, they did not consider either videos where students only face the lecturer seeing no slides or videos that combine viewing the lecturer and the slides. We also do not know why they decided on the chosen forms of video presentation. In our study, we first want to get an impression of how learning videos are currently designed. Furthermore, our focus is on the learning effect of different video presentations. For this reason we want to examine the most common styles of video presentation and focus on how students remember the learning content. We define content understanding as the degree to what extent students can absorb the content of the lecture and can reproduce or use the knowledge they have acquired.

3 REQUIREMENT ANALYSIS

As a basis for our main study, we conducted an initial study to examine the current techniques that professors are using for online lectures. We wanted to find out how content is presented frequently

during an online course in order to be able to design a realistic main study.

3.1 Method

For this purpose, a questionnaire was drawn up in which questions were asked about the use of technology and the presentation habits of the lecturers in online lessons.

3.1.1 Design. Our requirements analysis consists of an online questionnaire in Google Forms¹, which can be subdivided into three areas. The first section asked for demographic information. Then we wanted to know about their technical equipment, such as microphone and camera they use. The third part included questions about the implementation of online classes. They were asked if they taught online courses prior to the Corona pandemic and if they delivered the courses live or offered a recording. In addition, they were asked which elements were mainly seen in the live courses or recordings. They could choose in a multiple-choice question between the options slides, lecturer (talking head), (digital) whiteboard/blackboard, or an additional option as a free text field. We also asked if they set up the background during an online course and, if so, whether they do so with software or green screen. Finally, they were shown a selection of images from camera perspectives and asked which perspective was most similar to that of their camera during an online lecture (Figure 1). Again, they could choose more than one option.

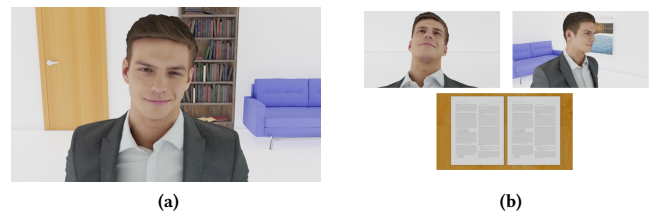


Figure 1: Selection of camera angles that we asked for in the survey. (a) Frontal is mainly used. (b) From below, the side and from above on a document are used less.

3.1.2 Procedure. The questionnaire was sent to lecturers at the University of Regensburg via mailing list, set up specifically for the corona pandemic for digital support. Also, it was passed on privately between lecturers. At the beginning of the questionnaire, the participants were informed about the aim of the study and about the anonymous use of their data. This was followed by questions about demographics, technical questions, and questions about their current implementation of online teaching. Finally, they could make general comments and leave their email in order to be informed about the results of the study. The questionnaire could be filled out from December 5, 2020 to December 22, 2020.

3.1.3 Participants. In total, 56 people took part in the online survey. Of these, 28 (50.0%) were male and 25 (44.64%) were female. Three participants did not provide any information about their gender.

¹<https://docs.google.com/forms/>

The answers to the questionnaire came from 15 different faculties of the University of Regensburg, with most (41.1%) belonging to the *Faculty of Linguistics, Literature and Cultural Studies*. Most of the participants (48.2%) work as research assistant at the university. Academic councillors (17.9%) and professors (14.3%) were also well represented. Different age groups are also represented in the survey. Thus, 23.2% of the participants were in the age between 20-29, 33.9% between 30-39, 23.2% between 40-49, 14.3% between 50-59 and 5.4% between 60-69.

3.2 Results

Of the people surveyed, 45 (80.4 %) stated that they had already held an online course before the corona pandemic. When asked how they do their online courses, the participants could choose from several answers. For example, 91.1% of those surveyed said they held their courses live and 48.2% provided a record. In addition, it was mentioned that they teach a hybrid form or provide asynchronous tasks.

When asked which elements they mainly show during a live online course, most of the participants (77.8%) show a lecturer, 68.5% mainly show slides and 31.5% show a whiteboard or blackboard. In addition, answers were given such as that multimedia content or videos, question / answer games or other programs / software were shown. It was also noted that the content is highly dependent on the situation.

When asked which elements are mainly shown during a recording, most of the participants (79.4%) said they were showing slides, 41.2% show a lecturer and 17.6% a digital whiteboard or blackboard. In addition, it was mentioned that students, multimedia elements / (learning) videos, other software, screen content or exercises are also shown. The differences between live lecture and video recording are presented in Table 1.

Table 1: Mainly shown elements related to live sessions and video recordings of a lecture

element	live	recording
slides	68,5 %	79,4 %
lecturer	77,8 %	41,2 %
blackboard/whiteboard	31,5 %	17,6 %

Furthermore, 71.4% of the respondents do not remove their background during an online course. Eleven participants (19.6%) use software to provide/hide their background. Moreover, most participants chose their camera perspective so that the lecturer looks straight into the camera (85.7%) (Figure 1a). Four participants each stated to have a camera perspective similar to one of the angles presented in Figure 1b.

3.3 Discussion

The results of our preliminary survey gave us some hints for carrying out the main study. First of all, most lecturers stated to hold their online courses either live or offer them as a video which means that they already have experience in presenting learning content in a video-like format. Slides, as well as the lecturer seemed to be the

most frequent shown elements while blackboards and whiteboards were presented less often in both versions. However, the lecturer is shown significantly less frequently when a recording is provided. For these reasons, we decided to use the two most common elements lecturer (talking head) and slides for our main study. We also chose to investigate a hybrid style, the picture-in-picture format. In addition, we considered the results of the camera angle as well recording the lecturer from a frontal perspective.

Nevertheless, it should be noted that the results of our survey only reflect the presentation styles of one university and that different software or hardware solutions at other universities can lead to different results. Since our main study also aimed to be carried out at the University of Regensburg, we decided to use the results of this study as the basis for the main study were we wanted to find out whether there is a difference in content understanding for different presentation forms.

4 INVESTIGATION OF CONTENT UNDERSTANDING

To investigate whether there was a difference in content understanding of different video presentations in online courses in this study, four different video lectures were shot on separate areas of photography. The subject of photography was chosen because we know a lecturer who is familiar with the subject and willing to help with the study. In addition, photography is not part of the curriculum of the faculty where the study is conducted. Certain courses did not have to be excluded in advance. Nevertheless, the topic has practical relevance that interests many people and is easily accessible. The slides with the content for the videos were created with the help of a research assistant who is familiar with the subject and has teaching experience. From this, three different video variants were worked out: Slides with audio, talking head, and picture in picture (PIP). Both, the videos and the slides were in German.

4.1 Method

In our main study we compared the three different types slides, talking head and picture in picture with each other. The video content is based on our findings of the requirement analysis, where slides and lecturer (talking head) are the main shown elements in an online lecture. We have also chosen a similar camera angle of the recordings based on the findings of the requirement analysis. Every video is around 10 minutes long because shorter videos are more engaging than longer ones [10]. In addition, the risk of the subjects being bored watching several videos should be minimized. All participants saw all four videos, but only video 2 and 4 were relevant for this study. After watching each video, the participants filled out a questionnaire with fill-in-the-blank, multiple choice and free text questions about the content of the video. Which participant sees which video type (slides, talking head, PIP) was counterbalanced.

4.1.1 Design. Based on the evaluation of the preliminary survey, we compared the following three types of videos, representing our independent variables, which can be seen in Figure 2:

- Slides: Only slides can be seen and the lecturer's audio can be heard in the background (Figure 2a)

- Talking head: The lecturer is visible over the whole screen and students can hear the audio. Slides are not shown. The lecturer looks straight into the camera (Figure 2b)
- Picture in Picture (PIP): Slides can be seen full screen as well as a small version of the lecturer in the lower right corner with the same camera perspective as talking head (Figure 2c)

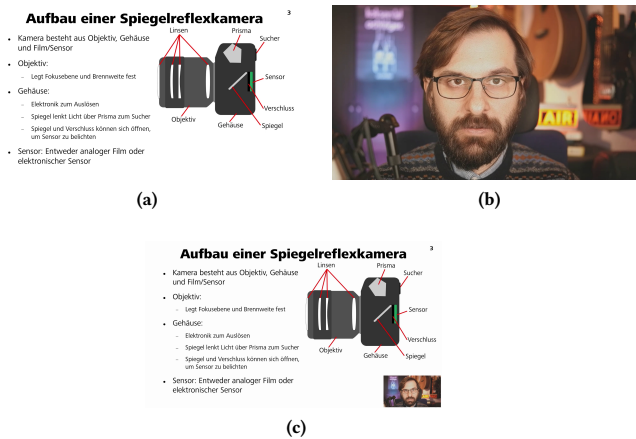


Figure 2: Video presentation forms we compared in our study. (a) slides, (b) talking head, (c) picture-in-picture

In total, videos were shot about four topics: history, functions of a camera, focal length and exposure. This study was conducted in a university context as part of a research seminar. Since another team was investigating a very similar research question, we shared our resources. This also allowed us to acquire as many participants as possible. However, we also split the learning video topics among ourselves. Our group investigated video presentation form with the topics functionality and focal length, while the other group investigated video quality with the topics history and exposure. This is the reason why only the data from the topics of functionality and focal length are of interest for this paper.

The three video types were created for each of these two topics. For this purpose, slides were created in collaboration with a research assistant and a lecturer then gave the appropriate lecture. During that, video, audio and the screen with the slides were recorded simultaneously and the three types of video were then cut from them. The videos were exported in HD resolution (1920x1080px) and with 25 frames per second.

For each topic, we designed an exam that contains questions about the content of the learning videos. In the exam, both the simple reproduction of knowledge using fill-in-the-blank, assignment or multiple-choice questions were asked, as well as transfer questions that had to be answered openly. Depending on the difficulty, points were assigned to the questions together with the research assistant who created the slides. The score achieved in these exams represent our dependent variable. With the aim of not making the exams too easy, we sent them in form of a google questionnaire to four subjects that did not get to see the learning videos beforehand.

Before they could answer the exam questions, we asked them to self-assess their knowledge in the general topic photography and the two narrower topics functionality of a camera and focal length on a seven-point Likert scale. Point 1 on the scale being "I do not know anything at all" and Point 7 being "I am a professional in this field". The median self-assessment on the general topic photography was 2, the median self-assessment on the topic functionality of a camera was 1.5, and the median self-assessment on the topic focal length was 1. The average exam score on the topic functionality of a camera was 18.98% while the average exam score on the topic of focal length was 17.68%. With these results we were certain that the exams we designed were difficult enough so that the average person could not pass the exams.

4.1.2 Apparatus. The necessary slides for the learning video topics were provided by a scientific employee of the University of Regensburg. This person knows the subject well and has experience in giving lectures. To make reasonable learning videos, we recruited another lecturer at the University of Regensburg who already has experience in (online) teaching. The lecturer already had the necessary equipment to shoot high-quality learning videos. He used a SLR camera and a professional microphone to record himself and his voice.

Considering the corona circumstances, we decided to conduct the study remotely. For this, we created a website on which the participants had to enter a unique code. This code and the last status were stored in a *Google Firebase Database*². If the participants decided to pause the study at some point, they could return to the website later and enter their code so that they could continue with the video where they previously decided to leave. If they have interrupted the study during the questionnaire, they started again with the video. The database was also used to programmatically counterbalance the order in which the presentation types were shown. Each exam for the learning video topics was created in Google Forms. To have more control on what the participants see and what not, we transformed the Google Forms into HTML and jQuery code with the *Google Forms HTML Exporter*³. The learning videos were uploaded as unlisted on YouTube. The transformed forms and the YouTube videos were then embedded into our website.

4.1.3 Procedure. The participation link for the study was posted in the university forum of the faculty and various student groups. The participants were able to access the website via the link. There the participants were first informed about the course of the study, gave their consent to the processing of their data and had to enter an abbreviation then, whereby the university's student abbreviation was recommended. With this abbreviation, they could pause the study and return to the next video later.

At the beginning of the study, the participants had to fill out a preliminary questionnaire about their demographics and previous experience in photography. Then the actual study started. First the participants were shown a video and after they had finished watching it, they were directed to the appropriate questionnaire, which asked for understanding of the content of the video. What kind of video was shown was determined by a function in the

²<https://firebase.google.com>

³<https://stefano.brilli.me/google-forms-html-exporter>

background in order to achieve a balanced order. The subjects of the videos were always in the same order: history, function, exposure, focal length. Before the participants left the page with the video, a popup asked whether they had finished watching the video to prevent errors. None of the questions about content understanding was a mandatory question and could be left blank if they didn't know the answer. The total duration of the study was estimated to be 60-90 minutes.

4.1.4 Participants. Our sample consists of 72 participants as we needed a multiple of 36 to ensure that each condition was tested at least once in a different order. Due to anonymization, aging was surveyed in 10-year groups. Most of the participants were between the ages of 20 and 29 years (88.89%), 9.72% were under 20 years old, and one person was between 30 and 39 years old. The majority of the respondents belonged to the Faculty of Linguistics, Literature and Cultural Studies (86.11%), as the study was carried out in this faculty. People from the faculties of computer science and data science (6.94%), human sciences (4.17%), and philosophy, art, history and social sciences (1.39%) also took part. One participant stated that he was still going to a vocational school.

In addition, the previous knowledge of the individual subject areas of the videos and the subject of photography in general was asked. On a scale from 1 to 7, the subjects tended to indicate that they only had some knowledge of general photography with Median = 3 (M = 3.58, SD = 1.48). For the history of photography topic, the Median was much lower with Median = 2 (M = 2.32, SD = 1.22), for functionality of a camera it was Median = 4 (M = 3.82, SD = 1.43), for exposure it was Median = 3 (M = 3.14, SD = 1.57), and for focal length it was Median = 2 (M = 2.63, SD = 1.80). Besides, the participants should specify on which device they are conducting the study. 55.56% of the respondents stated that they were sitting in front of a laptop and 41.67% in front of a desktop PC. One participant each carried out the study on a smartphone or tablet.

4.2 Results

Each participant watched two learning videos, each with a different topic and different video presentation format. For each video, the subject filled out a questionnaire with questions about the video content from which we could calculate the total points received. Due to the nature of the different video topics, it was rather difficult to design the questionnaires about the videos completely the same. Furthermore, we wanted to compare the results of the two topics to find possible differences regarding their difficulty or possibly descending concentration.

With this in mind, we calculated the total score by giving each correct answer a specific number of points due to the difficulty level of the question. After that, we normalized the final scores of each topic by dividing each score with the average achieved score for the respective questionnaire and multiplied the obtained value by the factor 50 as on average approximately 50% of the questions were answered correctly. Then we divided each normalized score with the highest achievable normalized score to get a normalized percentage of correct answered question per participant. As stated before, there were two different video topics that the subjects watched and answered questions upon, therefore there will be results stated for each video topic.

The calculated mean percentage of correctly answered questions for every video presentation form per video topic can be found in Table 2. For the video topic functionality, the video presentation form talking head has the lowest score with M = 52.33% (SD = 21.97%), slides has the highest score with M = 63.96% (SD = 21.75%), and picture-in-picture has a mean score of M = 58.96% (SD = 18.89%). For the video topic focal length, the video presentation form talking head has the lowest value with M = 44.92% (SD = 26.15%), slides is in the middle with a value of M = 48.16% (SD = 15.34%), and the video presentation form picture-in-picture has the highest value of M = 51.25% (SD = 24.68%). Figure 3 has a better representation of the mean scores of every video presentation form per video and includes the standard error.

Table 2: Mean percentages of correctly answered questions per video presentation form

	functionality		focal length	
	M	SD	M	SD
talking head	52,33 %	21,97 %	44,92 %	26,15 %
slides	63,96 %	21,75 %	48,16 %	15,34 %
picture-in-picture	58,96 %	18,89 %	51,25 %	24,68 %

To determine if there were significant differences between the means for the different video presentation forms, a one-way ANOVA was performed on each learning video topic. There were no statistically significant differences between the average percentage of correct answered questions of the three video presentation forms on the topic functionality of a camera ($F(2, 69) = 1.866, p = .163$). There also were no statistically significant differences between the average percentage of correct answered questions of the three video presentation forms on the topic focal length ($F(2, 69) = .473, p = .625$).

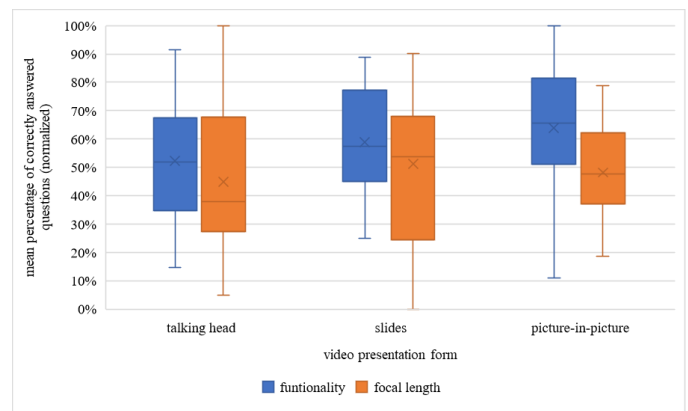


Figure 3: Mean percentages and standard error of correct answered questions per video presentation form

In addition, we counted per participant for each video presentation form the number of times it proved itself over the other presentation form in terms of percentage of correctly answered questions. Talking head had a better score than picture-in-picture

in 8 cases and a better score than slides in 9 cases. Picture-in-picture had a better score than talking head in 16 cases and a better score than slides in 12 cases. Slides had a better score than talking head in 15 cases and a better score than picture-in-picture in 12 cases. A better overview of these numbers can be found in Table 3.

Table 3: Number of times each video presentation form had a better score than the other presentation forms

	talking head	slides	picture-in-picture
talking head	-	15	16
slides	9	-	12
picture-in-picture	8	12	-

As stated before, the order of the seen videos was history of photography, functionality of a camera, exposure, and focal length. As the study was quite long, the concentration could have dropped from the second video topic towards the fourth video topic that we examined. We therefore looked at the mean percentages of correct answered questions per video topic. Functionality has a higher score than focal length 47 times and focal length has a higher score than functionality 25 times. Functionality of a camera has a mean of $M = 58.38\%$ ($SD = 21.16\%$) and focal length has a mean of $M = 48.12\%$ ($SD = 22.40\%$). We then performed a t-test for dependent samples and the result was that there is a significant difference in the percentage of correctly answered questions ($t = 4.241$, $p < .001$, $n = 72$). The effect size according to Cohen is $r = .449$, corresponding to a medium effect.

Therefore, it was also examined whether there was a difference in the number of points on the questionnaire if the participants had interrupted the study. A break longer than 60 minutes was counted as an interruption. Nine participants stopped the study before the functionality questionnaire, and a total of 14 participants before the questionnaire on the topic focal length. They could have interrupted the study either before the third or before the fourth video.

The participants who interrupted before the functionality video, with $M = 55.56\%$ ($SD = 25.22\%$) of correctly answered questions, performed slightly worse than those who did not interrupt the study ($M = 58.79\%$, $SD = 20.69\%$). In the questionnaire about the focal length however, the participants who had interrupted the study performed better with a mean of $M = 55.56\%$ ($SD = 23.20\%$) than those without interruption ($M = 46.31\%$, $SD = 22.03\%$). Then t-tests were performed on dependent samples and the result showed no significant difference in the percentage of correctly answered questions in either the functionality data ($t(70) = 0.426$, $p = .671$) or the focal length data ($t(70) = -1.395$, $p = .167$). Overall, 21 of the 72 participants took a break during the study.

4.3 Discussion

The results of our study are showing no significant difference in learning considering the presentation style of videos. We thus support the statement made by Homer et al. [7], who also found no significant difference in their research. In contrast to Guo et al. [6] who found that it is better to see the lecturer our participants

achieved better results when watching the slides or the picture-in-picture format while not both of them are containing the lecturer but a visualization of the spoken text. Moreover, we counted how often each presentation form proved itself over the others focusing on the percentage of correctly answered questions. This also gives some hints that the talking head style alone does not work that well. We therefore conclude that it may be helpful to see what the lecturer is talking about let it be any visual information such as texts, bullet points or pictures.

Our results also show that there is a significant difference in the percentage of correctly answered questions between the video topics functionality of a camera and focal length. An explanation for this could be that the concentration dropped during the study, as a continuous session could take up to 90 Minutes and 51 out of 72 participants did not take a break in between the videos. Another explanation for the difference in scores could be that the video topic focal length was just a bit harder to understand than the video topic functionality of a camera.

Overall, we can say that none of the tested video versions can be declared as clearly better. As Homer et al. [7] found, the presence of the lecturer increases the cognitive effort of the students while otherwise Ilioudi et al. [8] reported in their study that the talking head variant was more suitable for explaining more complex topics than only learning by book. So, the presence of the lecturer has its benefits, too. Keeping that in mind, we would recommend that instructors create their video content visually as well to make the learning process easier. We therefore suggest a combination of slides and the lecturer view like in the picture-in-picture format we used.

5 LIMITATIONS AND FUTURE WORK

In contrast to traditional lectures, which usually last 90 minutes, watching the videos in this study took only 10 minutes. So, it cannot be said how the learning effect results with longer videos. Moreover, the questionnaires for the videos were also filled in immediately after watching the videos. However, considering online courses, a test, such as the final exam, does not usually take place immediately after a lecture. For this reason, future studies, could also investigate the content understanding with longer videos. In addition, it could be measured how content understanding behaves when it is measured at different - and especially later - times.

Despite the short duration of the individual videos, it should be noted that the entire study was very long with a duration of 60-90 minutes. In order to find out whether the concentration in the later videos and questionnaires has decreased, we compared the mean values of the participants who paused with those who did not pause. There were differences, especially in the results of the questionnaire on the focal length. The participants who had paused performed better, but the t-tests did not show any significant differences in the results. A break of at least an hour was considered a pause. However, it was not examined whether a longer break had a greater influence on the questionnaire results. Also, we made no distinction between whether a participant took the break before the third or fourth video, but only generally whether there was a break before the questionnaire on the focal length for example.

What cannot be ruled out either, since the study was carried out without monitoring, is that the participants cheated in answering the questions. They were asked in the declaration not to read the answers to the questions anywhere but to answer them self. Therefore, it would be interesting to examine the effects on learning behavior when the examination takes place as usual in a presence form and under controlled conditions. One participant also noted that they are missing the face of the instructor when first having a video in which they can see the lecturer and then a video containing only the slides. This effect could be investigated in further studies for example by using a between subject design.

Moreover, there are several other presentation forms that could be investigated. As mentioned in the discussion we found no ideal online lecture format but maybe a picture-in-picture style could be beneficial. Future studies should investigate this kind of video presentation format and compare it to other established or not yet investigated formats in terms of content understanding. In our first study, for example, not many people stated that they show a whiteboard in their online class which is why we did not consider investigating a video presentation format where a digital whiteboard (Khan-style) is present in the main study. However, Guo et al. [5] concluded that a Khan-style is more engaging than simple PowerPoint slides. Future work could also consider studying the performance of this style in terms of content understanding while comparing it to other video presentation forms as well.

Finally, it should be said that this study was not a long-term study. So, it is only a snapshot of the chosen topic. And not only the presentation style, but also different learning video topics could be examined presenting real learning content of a specific lecture. Keeping this in mind it would be possible to conduct a long-term study during one or several semesters based on actual grades. This also reduces some disadvantages mentioned before like the cheating probability or the fact that the videos were too short. We therefore conclude that for the future, studies over a longer period, with different topics for learning videos and within real online courses would offer new insights.

6 CONCLUSION

With the corona virus being omnipresent many educational institutions were forced to move their presence classes to the internet. In our preliminary study we wanted to investigate how lecturers were affected in their work by the pandemic and examined current techniques in online teaching at the University of Regensburg. We used these findings as a basis for our main study where we wanted to find out whether there are differences in content understanding after watching videos with different presentation formats.

The results of our first study suggested that lecturers mainly showed themselves and slides which they prepared in advance. According to our survey black- and whiteboards were sometimes shown as well but were comparatively rarely shown elements. Considering the camera perspective, the overwhelming majority stated that they filmed themselves from a frontal perspective. With the newly found information, we decided to compare content understanding of the two presentation formats that were used the most as well as a combination of them.

This resulted in the following three presentation styles: talking head, slides, and picture-in-picture. Participants watched the pre-recorded learning videos and took an exam right after. We then calculated the scores of each video presentation form and compared them with each other. Our results show that there is no significant difference between the three studied presentations. However, the talking head had the lowest average of correct answered questions. This could imply that the presence of slides has a positive effect on content understanding and should always be shown when giving an online lecture.

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