Master thesis

A comparison of the effectiveness of Whiteboard Animation Videos versus PowerPoint Videos

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1. Summary

Video instruction is used more and more in (blended) online learning. Lots of different types of videos exist, but scientific knowledge on their effects and efficiency is lacking. Therefore, this study investigated the difference in six dependent variables: learning and five different student experience constructs (namely viewing time, ease of use, self-efficacy, satisfaction and usefulness) for two independent variables, namely the relatively cheap and easy to make PowerPoint Videos and the promising Whiteboard Animation Videos.

For this study, guidelines to design a Whiteboard Animation Video are derived from literature. Using these guidelines, a video about dieting is chosen and a PowerPoint video with the same audio is made according to existing design guidelines.

Sixty-five students were assigned to one of the two videos. After declaring their prior knowledge about dieting, they watched one of the videos, filled in a questionnaire about their demographics and made a post-test.

Analyses showed that the PowerPoint video and the Whiteboard Video scored equally good on learning, viewing time, self-efficacy and technology acceptance (perceived usefulness and ease of use). The Whiteboard Video was considered to give more satisfaction. In addition, learning in general had a significant positive weak to moderate relationship with self-efficacy and viewing time.

The results of this study can be useful for educational designers in choosing what kind of video to make. Only if the satisfaction of the student is really important, the more expensive Whiteboard Video should be chosen. If a PowerPoint Video is designed systematically and according to scientific guidelines, PowerPoint videos and Whiteboard Videos foster learning equally. Suggestions for further research are also given.

Key Words: [video lectures, whiteboard animations, PowerPoint, technology acceptance, student experience]

2. Introduction

Video instruction to spread knowledge is increasing in popularity (Bétrancourt & Benetos, 2018). Since online learning and flip the classroom practices are used more often, the development of instructional videos are on the rise (Chen & Wu, 2015; See & Conry, 2014). There are different types of instructional videos, for example talking head videos, PowerPoint Presentations and Whiteboard Animations. One of the most common methods nowadays is the use of PowerPoint Presentations (Chorianopoulos & Giannakos, 2013). They are relatively easy to make and therefore cheaper than other methods. However, the costs are not the only characteristics on which a choice should be based.

Each type of video has its method to deliver knowledge. Since there are no guidelines when to use which type of video, the question which video developers often ask is what kind of video is the most suitable to deliver knowledge to their students (Chorianopoulos & Giannakos, 2013; Guo, Kim, & Rubin, 2014). Each method has its strengths and weaknesses. This is why the video designer should design a video in such a way that the strengths are magnified and the weaknesses are reduced as much as possible (Kozma, 1994). However, the usefulness and usability, as well as the strengths and weaknesses of many different types of instructional videos have not yet been scrutinized (Chorianopoulos & Giannakos, 2013; Chen & Wu, 2015). Therefore, it could be hard to find the best kind of video. In addition, more research is needed to see what kind of media is easier accepted by the student (Liu, Liao, & Pratt, 2009).

With regard to Whiteboard Animation Videos, little research is done on their effect on learning, despite of its popularity (Türkay, 2016). The only available studies are those of Türkay (2016) and Wiseman (2013). Türkay (2016) studied the conservations and opinions of participants of four different medias, including Whiteboard Animation Videos. She found that Whiteboard Animations have a significant positive effect on enjoyment and engagement compared to the other three media (namely what she called 'audio only', 'text only' and 'electronic slideshow'). The effect on retention was only significantly positive compared to 'audio only' and 'text only' and not to video with static screenshots of the Whiteboard Video. A study often quoted by practitioners, the study of Wiseman (2013), cannot be found in a scientific paper format, but only as a video with an interview with Wiseman and the drawer Park. In his video, Wiseman stated that Whiteboard Animation Videos increase the amount of remembered information with 15% compared to talking head videos in which only a presenter is visible. He claimed that whiteboard animations grasp and hold attention. They are amusing and can foster a good mood and, thus enhance the retaining of the presented knowledge.

Unfortunately, since there is less documentation available about this study, some scepticism is in place. However, these two studies show that it is interesting to further investigate Whiteboard Animation Videos, as they might be the most effective way in which to teach using a video instruction.

In conclusion, scientific knowledge about the effect of whiteboard animations on knowledge retention is lacking. If the benefits are indeed that significant, teachers who use e-learning should make Whiteboard Animations instead of the more common PowerPoint Presentations. Therefore, this study will investigate the difference in learning effects, viewing time and perceived usefulness between Whiteboard Animation Videos and PowerPoint Presentations.

To do so, first a theoretical framework is made. In this framework the concepts of video lectures, whiteboard animation videos, PowerPoint Presentations, technology acceptance, satisfaction and self-efficacy are investigated. Next, the method for this study is determined and the results of the experiments are presented. Lastly, the conclusion, discussion and implications for practice and research will end this report.

3. Description of the organisational context

This research is conducted at the department of Instructional Technology at the University of Twente. This is one of the four technical universities in the Netherlands. The department of Instructional Technology, which is part of the faculty of Behavioural, Management and Social sciences (BMS), performs research in instructional knowledge and skills and designs instructional support to make people learn.

4. Theoretical framework

This chapter digs deeper into the concepts used in this study. First, it is about video lectures in general. Next, it will narrow it down to PowerPoint Presentations and Whiteboard Animation Videos and mention some strong and weak points of both. The fourth topic is the viewing behaviour of students and the last part is about ease of use, usefulness, satisfaction and self-efficacy.

4.1 Video lectures

Video lectures rise in popularity (Ronchetti, 2010). A lot of companies produce instructional videos (Chorianopoulos & Giannakos, 2013), but also the growth of YouTube and other online video hosting services contribute to the popularity of instructional videos

(Guo et al., 2014). Video lectures can be incorporated in an education setting in multiple ways (Ronchetti, 2010; Chorianopoulos & Giannakos, 2013). For example, students can be asked to watch a video before the traditional lecture starts, or, as in the so-called MOOCs: Massive Online Open Courses, students can watch videos instead of attending a traditional lecture.

There are multiple advantages and disadvantages of video lectures compared to traditional lectures. The benefits of a video lecture are that it can be watched at any time and in any place. Furthermore, the student can watch the video as often as they need and can even repeat or skip certain parts (Ronchetti, 2010). The most concerning downside of video lectures is that there is no interaction between the student and the teacher or fellow students (Ronchetti, 2010). In addition, research has shown that students find it difficult to start watching the videos (Bell, Cockburn, McKenzie, & Vargo, 2001) and stay motivated while watching the videos (Jensen, 2011).

4.2 PowerPoint Presentations

The software program PowerPoint provides an opportunity to design pages (called slides) with texts and graphs in a certain order, and thereafter allows one to present them on a computer screen or to print the slides (Parker, 2001). In addition, the electronic slide show can also be recorded to use as visual for a video. Adding a voice-over to it will make it a so-called PowerPoint Presentation (Guo et al., 2014). The advantage of a PowerPoint Presentation is that it is relatively cheap and easy to create compared to other types of video lectures.

PowerPoint slides are often designed intuitively (Kosslyn, Kievit, Russell, & Shephard, 2012). However, in order to make the most effective slides for the students, they need to be supported in encoding the material, processing it to their working memory and storing it into the long term memory (Kosslyn et al., 2012). If the slides are not designed correctly, which Kosslyn et al. (2012) found is often the case, the students will need to process unnecessary information, which will hinder their learning process.

Teaching with PowerPoint slides compared to teaching with the traditional materials has multiple benefits. Students benefit from the combination of words and images compared to learning from words alone (Mayer, 2005). In addition, PowerPoint slides can also increase motivation (e.g. Akhlaghi & Zareian, 2015) and students' perception of the credibility of the teacher (Ledbetter & Finn, 2018). Students especially like the core sentences, images, graphs and line by line structure in PowerPoint slides (Apperson, Laws, & Scepansky, 2008). It is expected that these effects also count for PowerPoint Presentations.

However, the effect on learning through PowerPoint slides is quite often analysed with different results (Baker, Goodboy, Bowman, & Wright, 2018). In a meta-analysis, Baker et al. (2018) found that this can be due to different reasons. They mentioned the experience of the user with the taught topic as an important factor, since the increase in learning using PowerPoint slides only existed for K-12-students and not for college students. Other factors found in their study were to what extent the learner was taking or was given notes and whether the PowerPoint slides were designed correctly, which all stimulates learning.

4.3 Whiteboard Animation Videos

Whiteboard (Animation) Videos, also known as video scribing or fast drawing, are videos in which a hand draws simple pictures and letters on a whiteboard, in combination with sound and a storytelling voice (Saini et al., 2019; Air, Oakland, & Walters, 2015). Whiteboard Videos can be made with a camera in front of a whiteboard or above a piece of paper (Bradford and Bharadway, 2015), but also with various software programs like Videoscribe. The recorded video can be accelerated and delayed, and narration can be included. The process of making the video is expensive because it is time-consuming: producing 1 minute of video costs around 1 hour of production (Douglas, Aiken, Geco, Schatz, & Lin, 2017). Another reason why making the video is expensive is that it is often done by specialized, external companies (Türkay, 2016).

Despite the costs, Whiteboard Videos have a positive impact on students' feelings: they are emotionally attractive (Bradford and Bharadway, 2015) and engaging (Mar, Ordovas-Montanes, Oksenberg, & Olson, 2016). Furthermore, the videos can display special attention-grabbing effects that other kinds of instruction videos cannot (Douglas et al., 2017). The next paragraphs will dig deeper into some of the other good and unique qualities of Whiteboard Videos.

4.3.1   Animations and learning.

Animations and dynamic graphics are relatively new in the field of learning (Tversky, Morrison, & Betracourt, 2002). Research showed that they do not automatically support better learning than static images: the design should be thought through very carefully (Tversky et al., 2002). However, in their meta-analysis, Höffler and Leutner (2007) found that instructional animations have a medium-sized overall advantage in comparison to static

pictures, especially if the animation contains useful information and is very realistic. In addition, it is important that the animation does not distract learners (Lowe, 2003).

The assumptions behind these findings can be found in the concepts of active processing, dual channel processing and limited capacity (Höffler and Leutner, 2007). According to the theory of active processing, students need to actively process information in order to learn (Wittrock, 1989). This processing can be done via two channels: the verbal and non-verbal channel, as stated in the dual coding theory (Paivio, 1986). Whiteboard Videos use the two channels, since they present the knowledge in both audio and drawings. According to the principle of multimedia learning, this is better for learning compared to methods where knowledge is presented in words or pictures only (Mayer, 2005). However, these two channels are not limitless: only a certain amount of knowledge can be stored at the same time in a person's memory (Baddeley, 1992).

Taking that into account, it is worth mentioning that Whiteboard Animation Videos can have the right pace by using animation to let all information appear gradually. By doing so, the amount of information that enters the brain will not overload the memory. Therefore, the student can gradually build a mental model and use more capacity for the important parts of the knowledge.

4.3.2   Social agent and learning.

Another advantage of most Whiteboard Animation Videos is the presence of the drawer's hand. According to the social agency theory, people learn better when they feel connected to the instructor (Mayer, 2005). This is because this connection causes the learner to put more effort into the learning materials (Mayer, 2005). In PowerPoint Presentations, nothing human is present. In Whiteboard Videos however, the hand and part of the arm of an instructor are visible, so this could make the learner feel more socially responsible to learn. This is especially important in e-learning because of its natural feeling of distance (Bouhnik & Marcus, 2006)

However, two critical notes should be made. The meta-analysis of Mayer (2005) points out that the feeling of social responsibility gets excited by high expressions of human gestures like eye contact and facial expressions. Since a hand cannot show these expressions, it could be that the effect is low. The second critical note is that the hand in the animations can also distract the viewers from the important information. Harp and Mater (1998) found that seductive details in texts harm learning by making the learners feel confused about what the important information in the text is. However, since the hand in Whiteboard Animation

Videos neither changes nor presents a lot of information, it is expected that it does not cause significant seductive details.

4.3.3 Pointing and learning.

The signalling principle states that people learn better when there are cues highlighting or pointing out the relevant parts of the material (Mayer, 2005). An extra effect of the hand in Whiteboard Animation Videos is the pointing of the pencil. The pencil automatically points to the new visual information, since it draws all the text and images. In well-designed videos, these animations will be aligned with the audio. Therefore, the viewers are guided to the relevant parts of the material.

4.4 Viewing time

In this research, viewing time will be defined as the time the student watches the video. This time can fluctuate more than the time attending a traditional lecture, since a video can be paused and certain parts can be watched again or can be skipped. This behaviour depends on a lot of different circumstances and beliefs, for example, the type of questions asked in a post-test and the information density in the shots (De Boer, Kommers & De Brock, 2011).

It makes sense that spending more time on a subject leads to more learning (Carini, Kuh, & Klein, 2006). However, this relationship is far from clear (Axelson & Flick, 2010). Even if students participate actively, they can learn nothing if the material is not sufficiently designed to deliver knowledge (Axelson & Flick, 2010). On the other hand, if students are not engaged in learning the material, they will learn nothing (Skinner & Pitzer, 2012). Therefore, learning and academic success can only be received by engaging with the material (Skinner & Pitzer, 2012). In conclusion: it would be interesting to see the difference of viewing time between the videos and to investigate if watching more of the video leads to better learning.

4.5 Technology acceptance, satisfaction and self-efficacy

Learners need to accept and use certain technology in order to make their performance optimal (Bowen, Young, as cited in Davis, 1989). This technology acceptance can be measured with the following two variables: perceived usefulness and perceived ease of use (Davis, 1989). Perceived usefulness is defined as the perception of a person about the added value of a particular tool for his or her achievements (Davis, 1989). A high score in perceived usefulness indicates that the learners believe that using the tool will be positive for their

performance (Davis, 1989) and will increase their satisfaction of the tool (Drennan, Kennedy, & Pisarski, 2005). Ease of use is defined as the perception of a person about the amount of effort that is needed for using a particular system (Davis, 1989). A high level of ease of use means that the student perceives the video as easier to use. It is important to know the perceived usefulness and the perceived ease of use since they are indications whether the learners will be motivated to use the same technology later as well (Saadé & Bahli, 2005). This could be especially important for online learners since they need a high level of self-discipline to start and continue learning (Bouhnik & Marcus, 2006).

Zhang, Zhao and Tan (2008) found that not only the perceived usefulness is important to predict if a learner will accept the technology, but also the enjoyment of the learner. This can be measured by the variable satisfaction, which is defined as the degree to which the learner experience positive emotions during the task (van der Meij & Böckmann, submitted).

Self-efficacy is another factor that can motivate learners to learn and give better learning results (Bandura, 1997). Self-efficacy is defined as the personal beliefs of the learners about their ability to successfully perform a task (Bandura, 1997).

5. Research questions and hypotheses

The aim of this research is to gain more insight into the difference in learning, viewing time, ease of use, usefulness, satisfaction and self-efficacy between PowerPoint Presentations and Whiteboard Animation Videos. The amount of learning for each student will be measured by a post-test. Viewing time will be measured by using a viewing log. In addition, technology acceptance (perceived usefulness and ease of use), satisfaction and self-efficacy will be measured by a questionnaire. Some spontaneous remarks of students will also be used to gain more knowledge. In short, the research questions and hypotheses are:

1. To what extent does the type of video influence the user experience (viewing time, perceived usefulness, ease of use, satisfaction and self-efficacy)?

In line with the study of Türkay (2016), it is expected that Whiteboard Videos score higher on satisfaction. It is also expected that Whiteboard Videos score higher on ease of use, because of the animation and pointing. No specific hypotheses are formulated for the other dependent variables.

2. To what extent does the type of video influence learning?

It is expected that Whiteboard Videos score higher on learning, since they are more engaging. Furthermore this hypothesis is in line with what Wiseman (2013) found in his study.

3. What is the relationship between the user experience (viewing time, perceived usefulness, ease of use, satisfaction and self-efficacy) and learning?

It is expected that viewing time, perceived usefulness and self-efficacy have a positive relationship with learning. No specific hypotheses were formulated for ease of use and satisfaction.

4. To what extent does the video type influence the scores on the different types of questions (namely open and closed questions, remember, apply and understand questions and voice-only and visuals-only questions)?

Just as learning in general, it is expected that the Whiteboard Animation Video scores better on open and closed questions. In addition, it is expected that the Whiteboard causes deeper learning, resulting in higher scores on the apply and understand questions. Furthermore, it is expected that the Whiteboard video scores better on the voice-only and visuals-only question, since it is expected that learners are more engaged in that video.

6. Method

This chapter outlines the method of this study. First, the research design is set, and subsequently, the respondents are described. Next, the instrumentation, procedure and data analyses are explained.

6.1 Research design

This study is a quantitative study and uses an experimental design to answer the research questions. Two online GoLabs environments are designed, one with a PowerPoint Presentation and the other with a Whiteboard Animation Video. Students first saw one of the two videos. A post-test was administered to study the learning effects. A log to measure the viewing time gave insight into the engagement of the student and a questionnaire stated some personal characteristics and the perceived experience of the video.

6.2 Respondents

Some students had to be excluded because they did not follow the rules. In the end, 65 students of universities in the Netherlands participated according to the rules. All students participated voluntarily and gave their permission to participate in the research, so the homogeneous sample was not fully random. Twenty-eight students received participation credits for taking part in this study. Others received a voucher (n=21) or chose no reward (n=16). Using simple random sampling, 33 students were assigned to the experimental

condition and 32 to the control condition. Since the aim was to see the difference between the two groups, more than 30 participants per group gave sufficient power (VanVoorhis & Morgan, 2007).

6.3 Instrumentation

Several instruments are used to conduct this research. First, the pre-question and post-test will be discussed. Next, the characteristics of the two videos are exhibited. Thirdly, the video viewing logs, and lastly, the questionnaire for demographics and experience are explained.

6.3.1 Post-test.

The post-test consisted of 10 questions (4 multiple choice and 6 open questions) about the topic of the video. The same test was used for both kinds of videos. With the choices for the questions, Bloom's Taxonomy was taken into account (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956). This taxonomy states that there are different levels of knowing, ranging from the lowest level of remembering to the highest level which is creating new work. The questions in the tests were categorized in the first three levels, namely remembering (6 questions), understanding (2 questions) and applying (2 questions) the knowledge. Furthermore, the requested knowledge was ensured to be spread throughout the video. Lastly, the questions were designed to indicate some more information about the differences between Whiteboard Animation Videos and PowerPoint Videos. For example, the answer to the question 'What is the best meal to eat proteins?' was only included in the narration, not in the visuals. If differences in answers between the two videos were found, it could be stated that the visuals were more or less distracting. The questions and test can be found in Appendix A.

Learning was calculated as the percentage of gained points on the post-test. For people who answered all questions, the maximum score of 1 corresponds with 14 gained points on the test. However, some of the participants did not answer all questions, due to technical problems or other issues. If that was the case, the score would be calculated using the gained points derived by the number of achievable points of all answered questions. However, if students did answer so few questions that they were not able to collect at least 75% of the points (if they had answered all questions correctly), their total score will be indicated as missing.

6.3.2 Videos.

Two videos were used: one Whiteboard Animation Video and one PowerPoint Presentation. Each student saw only one of the videos.

6.3.2.1 Whiteboard Video.

No specific guidelines exist for creating Whiteboard Animation Videos. However, Mayer (2005) designed some principles for multimedia learning which can also be applied here, since Whiteboard Videos are a combination of words and drawings. These principles are also used to select a Whiteboard Video for this study. In the end, the video called "What's the Best Diet? Healthy Eating 101" from the YouTube channel 'DocMikeEvans' was selected.

Information quality and quantity.

In choosing the video, the total amount of information is taken into account. The information should not have been too much or too hard to understand, since no prior knowledge for the students was required. However, the amount of information should be enough to enable asking some post-test questions. Therefore, the selected video was 15 minutes and 13 seconds and was considered to have a good amount and level of information.

Signalling and embodiment principle.

As mentioned before, in Section 4.3.2 and 4.3.3, the drawing hand in Whiteboard Videos stimulates the attention to the new concepts and the connection between the student and the teacher. These both stimulate learning. Therefore, a criterion for the Whiteboard Video was that it must contain a moving hand that drew the images. As can be seen in Figure 1, this is present in the used Whiteboard Video.


a. PowerPoint Video

b. Whiteboard Video

"So I thought I would just focus on what I'd say if you and I sat down in the clinic."

Figure 1. Signalling and embodiment principle.

Personalization and voice principle.

Regarding the audio, there were also some criteria. In line with the voice principle, the voice had to be a human voice with a standard accent (Mayer, 2005). This gives the students the feeling that someone is directly speaking to them and does not distract the student in processing the spoken words. Furthermore, it would be a benefit if the narrator talked in a conventional style, instead of a formal style. Throughout the chosen Whiteboard Video this is the case. As an example, the narrator says in the shot of Figure 2: "So you can eat like a caveman…" instead of a more formal "So people can eat like a caveman…". In this way, the student feels more personally involved in the material, which stimulates deeper learning (Mayer, 2005).

| *a. PowerPoint Video* | *b. Whiteboard Video* |
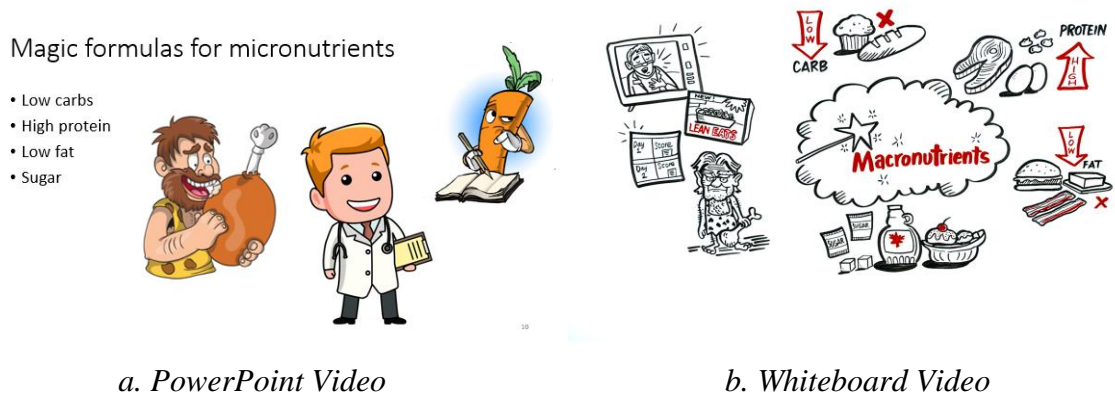
"Each commercial diet has their own magic formula of what we call macronutrients, so low carb, high protein, low fat, sugar and so on. And they typically have a story to go with it. So you can eat like a caveman, or use a scoring system or it's pre-packaged or famous doctor's take or whatever."

Figure 2. Personalization principle.

Coherence and spatial contiguity principle.

About the drawings and the texts, the coherence principle and spatial contiguity principle are taken into account. The coherence principle (Mayer, 2005) states that extraneous material needs to be excluded. In the used video, extraneous material is removed as much as possible. For example, some other Whiteboard videos on the web do not have a plain white background and proper lighting, while this is the case in the used video. According to the spatial contiguity principle, the words and pictures which belong to each other need to be presented near each other on the page, so the learner can easily make the connection between

the elements (Mayer, 2005). As can be seen in Figure 3b, this is the case in the Whiteboard Video, since the words are close to the drawing they belong to.

| a. PowerPoint Video | b. Whiteboard Video |
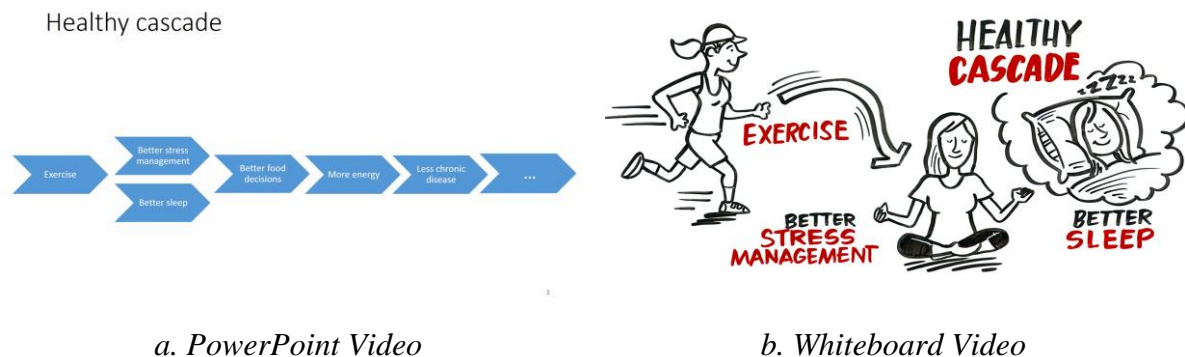
"I'd point out that eating is just one behaviour and a healthy cascade. Exercising regularly leads to better stress management and sleep which leads to better food decisions, to more energy, less chronic disease and so on."

Figure 3. Spatial contiguity principle.

Teaching concepts, processes and lists.

The Whiteboard Video teaches concepts, processes and lists in several ways. A characteristic of the videos is that hardly more than a handful of words per line appear on the screen. This paragraph digs deeper in how concepts, processes and lists in the Whiteboard Video are presented.

Concepts are mainly taught by the drawings. Almost all explanation happens through the drawings or spoken text. If words are used, it is mainly to name the concepts taught. An extreme example of the absence of written words can be found in Figure 4b. Here dr. Mike Evans explains what he means with "Awareness is undersold", but this can only be understood if the spoken text is also present.
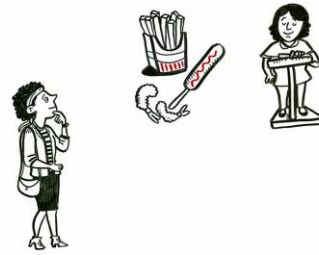
a. PowerPoint Video   *b. Whiteboard Video*

"So I think awareness is undersold. It may be what you're eating or weighing, […]"

Figure 4. Concepts in the Whiteboard Video.

In Whiteboard Videos, processes and lists are always presented by drawings. Most of the time, the enumeration is not in one shot, since zooming techniques are used. The drawings are sometimes accompanied by a few words that explain the drawing. The difference between a process and a list is that the drawings in a process are connected by arrows, while the ones in a list are not. An example of a process can be found in Figure 3 and an example of a list can be found in Figure 5.

a. PowerPoint Video   *b. Whiteboard Video*

"So, in the end, I hope I've got you to think a bit differently about how you eat: instead of investing in a single diet, a portfolio behaviours. Small tweaks over big changes. Single-ingredient foods over multi-ingredient and processed foods. Dinner at home, self-awareness, depending less on constant willpower […]"

Figure 5. Lists in the Whiteboard Video.

6.3.2.2 PowerPoint Video.

The PowerPoint Video was created using the design principles of Kosslyn et al. (2012). They came up with eight psychological principles to keep in mind when designing a

PowerPoint presentation, so learning can occur most easily. The eight principles can be organized into three groups: stimulating encoding, activating the working memory, and accessing long-term memory.

Encoding principles.

The first three principles belong to the encoding group. These principles make sure the students see and process the observed knowledge (Kosslyn et al., 2012).

The first principle is the Principle of Discriminability. This principle states that there is no place for camouflage in a presentation, so two components need to differ so much (for example in colour or size) that they can easily be distinguished. Font sizes can easily be distinguished if the font size is 3 points different (Krygier & Wood, 2016). Therefore the font sizes 24, 28 and 44 are used in the PowerPoint, as can be seen in Figure 6a. Furthermore, the background of the PowerPoint Video is white, so there is little distraction and it has the same background colour as the Whiteboard Video.

a. *PowerPoint video*	b. *Whiteboard Video*

*"*Many of our patients have high cholesterol and Dr David Jenkins and his colleagues here at the University of Toronto, have shown they can reduce cholesterol by 35 per cent with the portfolio diet.*"*

Figure 6. Principle of Discriminability.

The second principle is the principle of Perceptual Organization, which states that students automatically make groups of the presented elements, so they can remember the groups and not each separate element. An example of how this principle is applied can be found in Figure 7. Here it can be seen that images are directly connected to the term they apply to. In addition, the images are placed in such a way that it cannot be doubted that there are two separate groups, not more or less. Another example is that there are a lot of enumerations in PowerPoint Videos. On the one hand, this is due to this principle, so people

do not need working memory to group the elements themselves, but on the other hand, this is also just the main characteristic of PowerPoint slides. The Whiteboard Video also contains enumerations but presents them less clear. There are no bullet points to make a nice structure and zooming techniques are used to make the drawings bigger. An example can be seen in Figure 6, since Figure 6a shows all diets, while Figure 6b shows only the portfolio diet. On the one hand, this can cause better focus, but on the other hand, it gives a worse overview.

a. PowerPoint Video
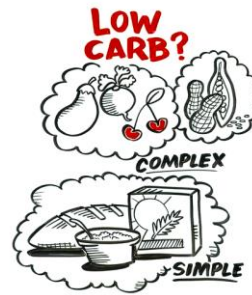
b.   Whiteboard Video

"Low carb? Well, carbs can be healthy in their complex form: fruits, veggies, legumes, whole grains and not so healthy in their simple form, like free sugars and refined starches. You know let's face it. Carbs taste awesome and our society tends to overeat them. So people who restrict their intake tend to lose weight."

Figure 7. Principle of Perceptual Organisation.

The Principle of Salience states that large differences grasp the attention of the viewer. Therefore, the elements that need attention need to be designed different than the rest of the elements. In this PowerPoint Video, this is done in all slides by adding each bullet point individually. This also stimulates the effect of the animation in Whiteboard Video as much as possible.

Working memory principles.

The fourth and fifth principle help students process new information in their working memory.

The Principle of Limited Capacity causes the slides to have a limited amount of information included because students cannot retain and process too much information at once. Therefore, the amount of information on a slide is low. In addition, the Whiteboard Video violates this principle sometimes by adding unnecessary drawings, clouds of thoughts and jokes. For example, the elf in Figure 8b was first flying around until the book with 'My

diet' fell on her from the sky on her. The pacing of the video is also important for this principle since students need time to process the presented information. Since the audio of the Whiteboard Animation Video is also used in the PowerPoint Video, the pacing is the same. However, this audio contains some sound effects which make sense in the Whiteboard Video, but not in the PowerPoint Video. These audio effects could not be removed without deleting spoken information, so they are still there. These audio effects in the PowerPoint Video can be distracting and annoying for the students.

a. PowerPoint Video   *b. Whiteboard Video*

"So to reframe this: our society lurches from diet to diet looking for some magic formula. But it's not the formula as much as the pattern. Instead of obsessing about the exact composition of a diet, the science tells us to choose the one you like the best and can actually stick to."

Figure 8. Principle of Relevance.

The fifth principle is the Principle of Informative Change. This states that people assume that new information is presented by a noticeable change and that a noticeable change presents new information. This principle is applied by making the bullet points appear individually and by having a descriptive title on every slide. Whiteboard Animations usually do not have a title on every page. In addition, if there is a title, the title is not always clear, because it is not always placed on the top (see Figure 9b). This could make it harder for the student to grasp the main message of the page.

Nudge 1: Weighing yourself (1)

• Challenge is to keep weight off
• Nudge:

Weighing yourself   Losing weight

28
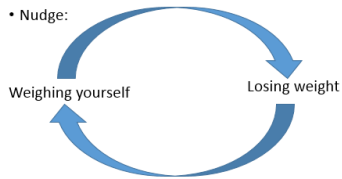
a. PowerPoint Video   b. Whiteboard Video

"Feedback loops seemed important. Losing weight is one thing, but it seems like the trickier part -at least for about 80 per cent of us- is keeping it off. Weighing yourself and using this as a small nudge in your daily food decisions is an example."

Figure 9. Principle of Informative Change.

Accessing long-term memory principles.

The last three principles ease the access of the students to their long-term memory. In that way the new material can be associated with the existing knowledge, so the meaning of the material can be understood.

According to the Principle of Appropriate Knowledge, students need to have prior knowledge of the used concepts, symbols and jargon. This is applied in the video by using the same audio in the Whiteboard Video, so there is no difference in terminology. Furthermore, clear images are used in the PowerPoint Video. These images are coloured cartoon images. The cartoon images are chosen because they look the most like the drawings in the Whiteboard Video. However, they are coloured since that is more natural and more common in PowerPoint Videos. Pictures of the researchers are not in cartoon style, but for this portrait photos with a plain background were chosen, as can be seen in Figure 4a.

The Principle of Compatibility states that the form and the meaning of the information need to be in line with each other. An example of how this principle is applied can be found in Figure 10. Here the bad side of the arrow is in red, while the good side is in green.
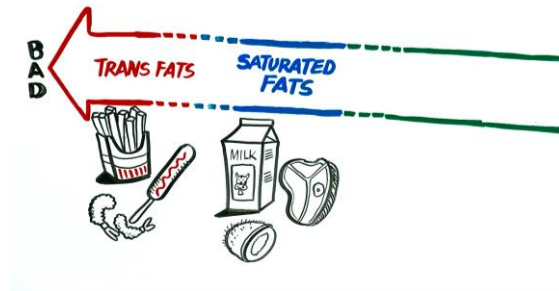
| *a. PowerPoint Video* | *b. Whiteboard Video* |

"How about low fat? Well. I think our story changed on fat from all bad to again more of a continuum. You know trans fats, so fried fast food, many packaged baked goods: not so good and we're reducing these. We have saturated fats: mostly in dairy and red meat, and plant oils, like coconut or palm. These seem not so good in excess but okay in moderation."
Figure 10. Principle of Compatibility.

Lastly, the Principle of Relevance states that the right amount of information needs to be presented at once. Both too much and too little information can hinder learning. The result of this principle is that sometimes words are chosen to present information, while it is presented with drawings in the Whiteboard animation video. This is because the ambiguous nature of pictures can distract learning. An example can be found in Figure 6 in which way more words are used in the PowerPoint Video than in the Whiteboard Video.

Teaching concepts, processes and lists.

The PowerPoint Video teaches concepts, processes and lists in different ways than the Whiteboard Video.

The spoken explanation of a concept is always accompanied by written words. For example, in Figure 11 it is explained what 'sitting disease' is. In the PowerPoint video, enumeration bullets are used to explain the situations causing the sitting disease (see Figure 11a). Most of the time, the concept can be understood without the audio. Therefore, the information is presented in more than one way, which can hinder learning, according to the redundancy principle of Mayer (2005). However, in lectures, it is still common to use both, so the slides (without audio) can be studied by the students after the lecture.
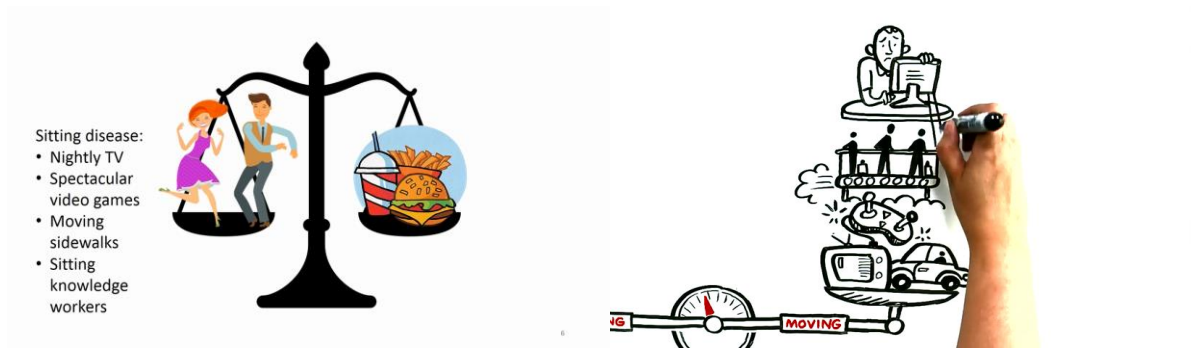
a. PowerPoint Video   b. Whiteboard Video

"The other side of the energy balance equation i.e. activity has also changed as our generation has a severe case of sitting disease. Nightly TV, commutes, spectacular video games, moving sidewalks and most of us now are sitting knowledge workers."

Figure 11. Concepts in a PowerPoint Video.

In a PowerPoint Video, a list is always presented by using bullet points. As can be seen in Figure 12a, the list can have different levels, using different font sizes and tabs. This may help students to structure new knowledge more easily, which helps to build a mental model (Mayer, 2005). The difference between a list and a process is not always clear in a PowerPoint since most of the time they are both presented by bullet points. An exception is in Figure 1a, where a visual with arrows is used to present the process.
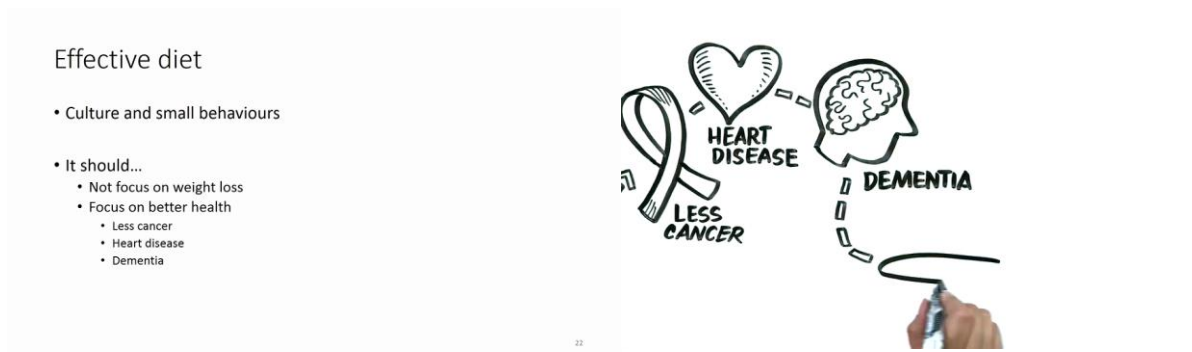
a. PowerPoint Video   b. Whiteboard Video

"A diet not focused on weight loss but in healthy outcomes, like less cancer, heart disease, dementia […]"

Figure 12. Lists in a PowerPoint Video.

6.3.3   Viewing Logs.

The behaviour of the students was measured using a built-in video analysis tool. The viewing log indicates the amount of time a student watched the video. This time is a ratio measurement. The videos were both 913 seconds long.

6.3.4   Questionnaire for demographics and experience.

The questionnaire asked the student a few characteristics, such as age, gender and study field. The student characteristics have a nominal measurement level. In addition, the students had to indicate their knowledge about dieting on a scale of 1 to 10. This is an ordinal scale.

Moreover, the questionnaire also contained questions to measure the perceived usefulness, ease of use, satisfaction and self-efficacy of the video. The same questions were adopted from the study of Van der Meij and Böckmann (submitted), who studied these variables for recorded lectures. For each variable 4 to 6 questions with a 7-points Likert-scale –ranging from 'strongly disagree' (1) to 'strongly agree' (7)– were used to measure this with an ordinal measurement level. The full questionnaire can be found in Appendix B. Perceived usefulness was measured with statements like '*PowerPoint Videos/ Whiteboard Animation Videos* are a useful resource' and '*PowerPoint Videos/ Whiteboard Animation Videos* like this are important in education'. Perceived ease of use was measured with items like 'It was easy for me to stay concentrated on the video' and '*PowerPoint Videos/ Whiteboard Animation Videos* are easy to use'. Thirdly, Satisfaction was measured with items like 'It was a gratifying experience to view the video' and 'I was content with what the video had to offer me'. Lastly, self-efficacy was measured with statements like 'I understood the main idea(s) of the whiteboard video' and 'I am confident that I will do well on a knowledge test on the whiteboard video'. The experience regarding viewing time, perceived usefulness, ease of use, satisfaction and self-efficacy, was calculated by taking the average of the scores on the statements. The minimum requirement of answered statements per construct is set on 75%, to correctly calculate the constructs.

Reliability analyses showed that one statement to measure ease of use should be deleted. Thereafter, there were good to perfect Cronbach's alpha scores for the four constructs (usefulness = .91; ease of use = .71; satisfaction = 0.94; self-efficacy = 0.91).

6.4 Procedure

When students wished to participate, a link to one of the two environments was sent to them, based on their random assignment to the experiment group or the control group. Students were advised to take their time and go to a quiet place before starting the video. After creating a username and filling in an informed consent, the student answered the pre-question and watched the video. The students were told that they are allowed to pause, review or skip parts of the video. After they watched the video they filled in the questionnaire and finally made the post-test. In the end, the students could optionally leave a comment and sign up for the reward.

6.5 Data analyses

This study is a quantitative study and applies an experimental design to answer the research questions.

To compare the groups on demographics, two kinds of analyses were executed with both an α of .05 (two-tailed). For the continuous variables age and prior knowledge, a t-test was used. For the categorical variables gender and education, the chi-square test was made use of.

One-way ANOVA analyses were conducted to determine if the user experience and the knowledge about the topic differed at the $p<.05$ level between the two kinds of videos. Next, a correlation analysis was executed to determine the relationship between the user experience constructs and learning. For this, a significance level of .05 was used.

For some extra analyses, some one-way ANOVA analyses with an α of .05 were utilized to determine if there is a difference in the scores on some groups of questions between the two videos. Lastly, it was determined if the students scored differently on specific questions by using chi-square analyses with a two-tailed significance level of .05.

6.5.1 Exclusion of participants.

As mentioned before, some students were excluded because they did not follow the instructions correctly. Some other students were excluded for some specific analysis because they had missing answers. Table 1 gives an overview of these students. They are not totally excluded because they can still valuably contribute to the other parts of this study. This is also why the analyses have different degrees of freedom.

Table 1

Partially excluded students

Reason of exclusion	Number of students excluded	
	PowerPoint Video	Whiteboard Video
Answer about prior knowledge is missing	0	1
Less than 75% of answers for the constructs usefulness, satisfaction and self-efficacy	0	1
More than 25% missing points on the post-test	3	0

6.5.2 Interrater agreement on post-test.

Cohen's κ was calculated on 10% of the open questions of the post-test to determine the agreement between the first and second corrector on the scores. There was substantial agreement between the two correctors, since Cohen's κ was .79 (95% CI [.64, .94]), $p < .001$.

6.6 Comparison of conditions on demographics

Analyses on age, prior knowledge, gender and education were performed to see if there was a significant difference in one of these factors between the two video conditions. The results can be found in Table 2 and 3.

A t-test showed that the difference in age between the Whiteboard Animation condition and the PowerPoint Video condition was not significant, $t(63) = 0.48$; $p = .630$. In addition, the t-test about the self-indicated prior knowledge showed no difference between the Whiteboard condition and the PowerPoint Video condition, $t(62) = 0.16$; $p = .832$.

Table 2

Results of the demographics age and prior knowledge

	PowerPoint Video			Whiteboard Video		
	N	*M*	*SD*	*N*	*M*	*SD*
Age	32	22.15	4.42	33	21.69	3.20
Prior knowledge	32	6.16	1.57	32	6.09	1.51

Note. Age is measured in years. Prior knowledge is indicated by the students on a scale of 1 to 10, with 1 as very bad and 10 as very good.

The chi-square test showed no differences in gender between the Whiteboard condition and the PowerPoint condition, χ^2 (1, $N = 65$) = .13, p = .724. For the chi-square test regarding education, groups were made. The three groups were (1) Natural Science and (2) Social Science and (3) Other (namely Humanities, Formal Science and Health Care). The test showed no differences between the two conditions, χ^2 (2, $N = 65$) = 1.09, p = .581. To conclude, the random sampling was effective to make two similar populations for the conditions on age, prior knowledge, gender and education.

Table 3

Results of the demographics gender and education

| | | Number of students | |
		PowerPoint Video	Whiteboard Video
Gender	Male	13	12
	Female	19	21
Education	Natural Science	9	6
	Social Science	19	21
	Other	4	6

7. Results

In this chapter, the results are discussed. First, the results of the influence of the type of video on the user experience are stated. Thereafter, the influence of the type of video on learning is described. Lastly, the results of the relationship between user experience and learning are presented.

7.1 Type of video and user experience

Table 4 shows the results of the user experience constructs per condition. The videos were 913 seconds long, so on average, the majority of the video is watched. All other experience constructs scored quite above neutral (3.5), which shows an overall positive experience towards the videos.

Only the difference in satisfaction is significant, $F(1, 62) = 6.61$, p = .013. The other constructs had no significance difference between the two conditions (Video viewing: $F(1,$

63) = .04, p = .844; Perceived usefulness: $F(1, 62)$ = .00, p = 1.000; Ease of Use: $F(1, 63)$ = .02, p = .904; Self-efficacy: $F(1, 62)$ = 2.80, p = .100).

Table 4.

Results of the user experience constructs

	PowerPoint Video			Whiteboard Video		
	N	*M*	*SD*	*N*	*M*	*SD*
Video viewing	30	944.92	198.04	32	872.97	61.67
Perceived usefulness	30	5.18	1.16	32	5.18	1.08
Ease of use	30	5.07	.95	32	5.10	1.08
Self-efficacy	30	4.66	1.12	32	5.12	1.06
Satisfaction	30	4.41	1.27	32	5.24	1.32

Note. Video viewing is measured in seconds. The other constructs are measured on a scale of 1 (strongly disagree) to 7 (strongly agree).

Regarding user experience, one student who watched the Whiteboard Video declared spontaneously after participating in the study: "The topic of the video highly influences my opinion. The results would be different for a more sophisticated topic." Another student from the same condition stated: "I very much enjoyed the video!". Lastly, another student declared: "The video was way too stressful because of the hand that was moving so fast all the time. [It is] unnecessary to show the hand. Just show the finished drawings".

7.2 Type of video and learning

The results of the effect of the type of video on learning are shown in Table 4. On average, students received 62.9% of the points. The statistical test showed no significant difference between the two videos, $F(1, 61)$ = .08, p = .780.

Table 4

Results of learning

	PowerPoint Video			Whiteboard Video		
	N	*M*	*SD*	*N*	*M*	*SD*
Learning	30	.62	.18	32	.63	.15

Note. Learning is measured in percentages of received points. A score of 1 is equal to 14 points.

Some students made a spontaneous remark about learning with the videos. Two students of the Whiteboard Video said that the aim of the video is important, stating: "I think Whiteboard Movies are ideal for getting a quick overview or learning about a topic superficially. It can help with topics you need to study but only as supplementary material." and "I think whiteboard videos might be helpful in teaching, but I think they are mainly suited for a quick overview of a certain topic. If you want detailed and in-depth information, it would be better to have a regular lecture." A student from the PowerPoint Video condition declared the length of the video as important by saying: "For me, the learning effect and how much information will be remembered afterwards, depends on how long such a video is. In this case, it was too long for me to remember all the details".

7.3 User experience and learning

The relationship between user experience and learning can be found in Table 5. The results show that learning has a significant positive weak to moderate relationship with self-efficacy and viewing time. Also, a stepwise regression showed viewing time and self-efficacy as the most important variables to predict learning.

In addition, it can be found in Table 5 that usefulness, satisfaction and ease of use have a strong, positive and significant relationship with each other.

Table 5

Correlations for user experience and learning

	Usefulness	Satisfaction	Ease of Use	Self-efficacy	Viewing Time	Learning
Usefulness	-					
Satisfaction	.70*	-				
Ease of Use	.80*	.72*	-			
Self-efficacy	.73*	.76*	.74*	-		
Viewing Time	-.09	-.03	-.08	.00	-	
Learning	.04	.11	.22	.30*	.35*	-

* $p < .05$

7.4 Types of questions

Some other analyses were run to see if students in one condition scored better for a certain (type of) question than the other students.

Table 6 shows the results for some categories of questions. Differences were not significant for the categories with open questions ($F(1,61) = .17$, $p = .680$) and closed questions ($F(1,63) = .00$, $p = .968$). Also in the different categories of Bloom's taxonomy no significant differences were found (remember: $F(1,63) = .01$, $p = .917$, understand: $F(1,62) = .01$, $p = .717$ and apply: $F(1,58) = .15$, $p = .696$).

Table 6

Scores per category per condition

	PowerPoint Video			Whiteboard Video		
	N	*M*	*SD*	*N*	*M*	*SD*
Closed Questions (1 – 4)	32	.68	.22	33	.68	.21
Open Questions (5 – 10)	30	.62	.17	33	.60	.21
Remember Questions (1 – 5, 7)	32	.60	.19	33	.59	.19
Understand Questions (6, 8)	31	.77	.33	33	.75	.26
Apply Questions (9, 10)	27	.61	.31	33	.58	.37

Note. Scores are in percentages of received points for the applicable questions.

In Table 7, the results of all questions are presented separately. The results for questions 2 and 3 are significantly different (respectively $r(1) = 4.28$, $p = .039$ and $r(1) = 5.91$, $p = .015$). Question 2, a question where the students had to remember the average intake of sugar of American citizens, was answered better by the students in the PowerPoint condition. Question 3, a question for which the student had to remember a spoken number, was significantly better answered by the students with the Whiteboard Video.

Table 7

Scores per question per condition.

		Number of students	
Question	Score	PowerPoint Video	Whiteboard Video
1. What makes a diet work best?	0	3	5
	1	29	28
	99	0	0
2. How many teaspoons of sugar does an	0	6	14
average American take per day?	1	26	19
	99	0	0
3. How much kilograms weight loss can	0	24	15
daily weighing yourself gain?	1	8	18
(spoken text only)	99	0	0

4. What is the best time to eat proteins? *(written text only)*	0	8	8
	1	24	25
	99	0	0
5. What does PUFA stand for?	0	22	23
	1	10	8
	99	0	2
6. Doctor Mike talks about an 80/20 attitude. Explain what he means with that.	0	5	5
	1	1	2
	2	26	26
	99	0	0
7. Lowering sugar intake appears to be less effective than some other actions in reducing the risk of progression in diabetes. Name two factors which are more effective.	0	3	4
	1	21	20
	2	8	9
	99	0	0
8. Explain how it is possible that eating more can still give weight loss.	0	10	13
	1	21	20
	99	1	0
9. Instead of applying it to food, Kim wants to apply the principle of feedback loops to how she spends her money. Give an example of how she can do that and explain how it can help her spend less money.	0	11	11
	1	5	5
	2	14	17
	99	2	0
10. Name a problem why someone doesn't move enough and come up with a tweak for this problem.	0	9	14
	1	2	1
	2	16	18
	99	5	0

Note. '99' means no answer was given.

8. Discussion and conclusion

The purpose of this study was to see the difference in user experience and learning between Whiteboard Animation Videos and PowerPoint Videos. Therefore, in this section,

the research questions are answered. In addition to that, the limitations, implications and future research are addressed.

8.1 Effect of condition to learning and student experience

First, the three research questions are answered. Some statements are substantiated with literature and comments the students gave after completing the study. An interesting remark was made by one of the students. This student said that the topic of the video highly influenced his/her opinion. So, as also found by Caspi, Gorsky and Privman (2005), students might experience difficulties in distinguishing between the medium and the topic.

8.1.1 To what extent does the type of video influence the user experience (viewing time, perceived usefulness, ease of use, satisfaction and self-efficacy)?

This study showed that students are more satisfied with the Whiteboard Video than with the PowerPoint video. The type of video did not influence the ease of use, viewing time, usefulness and self-efficacy of the students significantly. The next sections dig deeper into these results.

8.1.1.1 Satisfaction.

As expected, the students had more positive emotions during the Whiteboard Animation Video. As a student who watched the Whiteboard Video said: "I very much enjoyed the video!" Since satisfaction can be nourished by the feeling of social presence (Gunawardena & Zittle, 1997), the presence of the hand in the Whiteboard Video can be the reason for the significant difference. Satisfaction can be an indication if the student will use the medium again later (Zhang et al., 2008), so a higher satisfaction for Whiteboard Videos can indicate that students are more likely to use that medium than a PowerPoint Video.

8.1.1.2 Ease of use.

Students did not perceive the Whiteboard Animation Video as a system that requires less effort to learn with. This was not expected, but can be due to the hand and the animations. These characteristics were expected to lower the effort needed to learn because of the pointing and graduality, but might, in this case, not be able to outweigh the negative effects of distraction. Animation can be useful in certain situations, e.g. presenting micro-steps or subtle changes (Tversky, et al., 2002), but may be less useful in a video about dieting. The hand

could be too extraneous and therefore hinder learning (Mayer, 2005). As one student declared that the video was too stressful since the hand was moving so fast. However, when students watch more Whiteboard Videos they might get used to the hand and then it might be experienced as less extraneous.

Watching more Whiteboard Videos can also help students to learn how to learn with a Whiteboard Video, so it can be used more easily. Back in 2005, Caspi et al. found that students need to get used to new learning media when they did an experiment comparing textbooks and learning videos.

8.1.1.4 Usefulness.

The Whiteboard Video was considered to be equally useful as the PowerPoint Video. Here the aim of watching the video can play a role. One student who watched the Whiteboard Video declared that (s)he thought that whiteboard movies are ideal for getting a quick overview of a learning topic but only as supplementary material. There is a possibility that the students considered the Whiteboard Video not totally in line with their personal aim, causing equal usefulness as the PowerPoint Video.

Combining the results for ease of use and usefulness, it can be stated that the videos do not differ with regards to the students' acceptance. However, also adding satisfaction as some scholars (e.g. Zhang, Zhao and Tan, 2008) suggest, might imply a better acceptance for Whiteboard Animation Videos.

8.1.1.3 Viewing time.

Students did not watch one of the videos longer than the other. This was not surprising since this behaviour can be influenced by a lot of factors. For example, viewing can be influenced by the students' cognitive needs or the assignment/test expected after watching the video (De Boer et al., 2011). Furthermore, it is possible that students who already know the topic or find the video boring, skip certain parts. On the other hand, not understanding or enjoying the video or mind-wandering might motivate the student to watch (a part of) the video multiple times.

8.1.1.5 Self-efficacy.

Students among the two conditions were equally confident in their ability to successfully perform a task based on the video. This can be because students nowadays are

more and more used to watching instructional videos in general (Chen & Wu, 2015; See & Conry, 2014). Apparently using either one video or the other does not stimulate the students' self-efficacy.

8.1.2   To what extent does the type of video influence learning?

This study showed that students do not learn more from a Whiteboard Video than from a PowerPoint video. This was not as expected since it was expected that the Whiteboard Video would be better for learning. The main reason for this hypothesis was that Wiseman (2015) found a positive effect. First, in Section 8.1.2.1, several possible arguments why learning is not stimulated more in the Whiteboard Video are stated. Next, in Section 8.1.2.2 some reasons why this is not totally in line with previous research are suggested.

8.1.2.1. General reasons.

First of all, the PowerPoint Video was designed according to the guidelines of Kosslyn et al. (2012). This structural approach to designing aimed at reducing the effort students need to put in the learning by helping to encode, process and store the new ideas and theories. It is possible that this structural approach resulted in a PowerPoint Video that was so good that the benefits of the Whiteboard Video faded in the light of the PowerPoint Video.

Secondly, it is possible that students did not get the best score results out of the Whiteboard Animation Videos because they were not used to it enough. Students need to adapt their learning strategies when they encounter new media (Caspi et al., 2005). In the beginning, something unfamiliar may be classified as extraneous material until a person is accustomed to it. Since quite some aspects of Whiteboard Animation Videos are unfamiliar to the students, it may take a while until they adapt to this new kind of learning media.

Lastly, the depth of the information and the topic taught might influence the efficiency of the Whiteboard Video. As one student suggested, Whiteboard Videos are mainly helpful to get a quick overview of a certain topic. He/She suggested that for detailed and in-depth information, a regular lecture would be better. Since the questions were quite detailed, it might be too precise for this kinds of videos.

8.1.2.2. Compared to previous research.

In general, it is possible that the results of these kinds of studies change over time. If the type of instructional media is new to a student, two effects are possible. On the one hand, the novelty effect can make the student who is exposed to the new media pay more attention

(Pace, 2004) and be more curious, which can result in better learning results (Türkay, 2015). On the other hand, students need to learn how to learn with new media (Caspi et al., 2005). It is possible that these effects have an impact on the results of this study, but this impact is considered to be low.

Türkay (2015) compared learning of four different kinds of videos, but only the Whiteboard Video is comparable with this study. The video most comparable with the PowerPoint Video is what she called an Electronic Slideshow. In this video, she used screenshots of the completed drawings to paste over the narration. When comparing the results of these two kinds of videos, no differences in learning were found. This is quite in line with this study. However, Türkay (2015) concluded stating that Whiteboard Animations are worth the money, while this study concludes that making them is not always worth the costs and effort.

Larger differences are found between this study and the one of Wiseman (2013). He found a learning gain of 15% when he compared Whiteboard Animation Videos with Talking Head Videos. In this last kind of videos, only the lecturer is visible, without any other visuals. This lecturer can add some gesture and signalling, but no images are presented. Therefore, the multimedia principle is violated, which states that students learn better when words and pictures are combined instead of words alone (Mayer, 2005). The lack of images in the Talking Head Video can cause the gain in learning in the Whiteboard Video.

Furthermore, the Whiteboard Video of Wiseman (2013) is designed in another way than the one in this study. In making the Whiteboard Animation, Wiseman worked together with an external company specialized in Whiteboard Animations. This company did not only made drawings corresponding with the audio, but also tried to connect the new knowledge to prior knowledge by adding (funny) drawings. This makes the content of the videos different, so less comparable to the Talking Head Video. In addition, adding other information can make it easier for the student to connect the new knowledge to prior knowledge. This can cause the differences in learning, since the students have to put less effort in adding the new knowledge to their prior knowledge, since that is already done for them. Therefore the students have more capacity left to learn other parts of the video, causing even more learning.

8.1.3 What is the relationship between learning and the user experience (viewing time, perceived usefulness, ease of use, satisfaction and self-efficacy)?

There is a positive correlation between viewing time and learning. This suggests that students who watched the video longer also learned more. While this relationship makes

sense, it is not always the case (Carini et al., 2006; Axelson & Flick, 2010). It could be that the students learned more from watching parts of the video multiple times or that the others skipped parts of the video. Kim et al. (2014) found that peaks in watching have to do with confusion of the student, the demonstration and introduction of important or interesting concepts or video production problems. In addition, repetition of material is used to ensure that information is understood correctly (Pathak & Kathpalia, 2005). The time people spend watching the video can also be seen as a measurement for student engagement (Guo et al., 2014). Learning can only occur through engagement if the design of the material is good (Axelson & Flick, 2010). Therefore, it can be said that the designs of the videos are good and that students who engage more with the material, learn more.

Another construct that had a positive correlation was self-efficacy. Therefore it can be stated that students with a high belief in their abilities perform better. This is completely in line with previous research, which stated that self-efficacy indeed is a predictor of students' learning (Zimmerman, 2000).

Usefulness had no significant correlation with learning. This implies that the perceived added value of the learning tool does not affect learning. Probably this is because the perceived usefulness is more about the acceptance and success of the tool (Alsabawy, Cater-Steel, & Soar, 2016) and not about the learned material. Therefore usefulness can be handy to predict whether students will use the tool again, but not to indicate their learning.

Ease of use also did not have a significant correlation with learning. This advocates that people do not learn better if they believe the video is easier to use. This can be explained by the fact that ease of use tells more about the effort to operate with the medium (Saadé & Bahli, 2005) than the effort on how to store the knowledge in the memory system.

Satisfaction and learning also did not have a significant relationship with each other, meaning that the emotions of the student during the task did not impact their learning. Not much previous research exists on the relationship between satisfaction and learning (Kim, Jo, & Park, 2016). However, Kim et al. (2016) found a slightly positive relationship between them. They explained this correlation by stating that their learners had various levels of academic achievement. Since this current study only uses students, it is assumed that there are no large differences in academic achievement. This can explain why there is no relationship between learning and satisfaction found in this study.

8.1.4 To what extent does the video type influence the scores on the different types of questions?

As stated before, both videos scored equally regarding learning. However, it could be interesting to investigate if one of the videos stimulated the correct answering of some type of questions better than the other. Therefore, groups of questions are formed and analyses are done on the relationship between these questions and learning.

8.1.4.1 Groups of questions.

No difference was found between the scores for the open questions, nor for the closed questions between the different types of videos. Also for the different levels of Bloom's taxonomy, no significant differences between the two types of video were found. This indicates that one video did not result in deeper learning in comparison to the other video. These were unexpected results, but possible explanations can be found in Section 8.1.2, namely that the PowerPoint Video was designed really carefully, that students are not used to Whiteboard Videos and that the topic of the video might have influenced the results. Especially the last reason has a strong impact here since it might be that, as one student suggested, Whiteboard Animations are more suitable for a quick overview instead of in-depth information.

8.1.4.2 Separate questions.

The hypothesis regarding the voice-only question (question 3) was confirmed: the students in the Whiteboard Animation condition scored better on this question. This could imply that the students who watched the Whiteboard Animation paid more attention to the spoken words, because the audio is really needed to understand the drawings. This can be due to the characteristics of the visuals in the two types of videos. In Whiteboard Videos the visuals cannot be understood without the audio most of the time. On the other side, PowerPoint Slides can almost all be understood without audio. This can cause the students in the Whiteboard Video condition to focus more on the audio than the students in the PowerPoint condition. Therefore, it is important to keep the voice principle and personalization principle in mind when designing a Whiteboard Video since students learn the most when they are being addressed in a conventional style by a standard accent voice (Mayer, 2005).

However, the hypothesis that Whiteboard Animation Videos were better on the visuals-only question (question 4) was not confirmed. This implies that the students paid equal attention to the images on the screen. This was not expected, but can be due to a combination of the characteristic that the drawings in the Whiteboard Video are less important (since not everything is presented there), but that they are more engaging at the same time. This can make the drawings in the Whiteboard Video equally worth remembering as the images/text in the PowerPoint Video.

For the other questions, only question 2 was answered significantly better by PowerPoint students. For this question, the students needed to remember the daily amount of sugar intake of an average American. No specific explanation can be found for the difference in correct responses between the two videos. It can be that the Whiteboard Video was way more extraneous in this part to store the right amount in the students' memory. To compare, the shots can be found in Figure 13. This highlights the importance to design the videos according to the coherence principle of Mayer (2015) which states that extraneous material needs to be excluded as much as possible.

a. PowerPoint Video   *b. Whiteboard Video*

"Well if I had to pick one word to describe sugar in industrialized societies it would be sneaky. So, so much sugar has worked its way into our diets. I mean many drinks have eight or more teaspoons of sugar"

Figure 13. Question 2.

8.2 Limitations

Although this study is designed and executed with care, there is still room for improvement.

First of all, the construct ease of use is only measured by four statements, after which one is deleted for more reliability. To measure ease of use more precisely, more statements can be added.

Secondly, the students were doing the experiments at their own place at their own time. Therefore it could be that some students were disturbed (e.g. by bad internet connection, or their mom calling them). However, this is also what could have happened if the video was a part of a real online course.

Thirdly, this study only investigated two videos, one for each condition. Türkay's (2016) videos were about a hard topic in physics, Wisemans (2013) video was about a psychological principle and this study had videos about health. Since some students reported that the topic of the video influenced their opinion, it would be interesting to see what happens if the videos are about other topics.

The used videos were around 15 minutes long, so there was enough knowledge presented to ask questions about. However, some students reported that the video was quite long. After watching the PowerPoint Video one student said that the video was too long to remember all the details. On the other hand, real lectures also take quite some time, so students are used to listening for a long time.

Lastly, it was not known to what extent the students were familiar with Whiteboard Animation Videos. It was considered in the beginning to ask the students about it, but then they would have had too much prior knowledge about the aim of the study. However, if other methods can be found to know the students' habituation to Whiteboard Animation Videos it can add great value to these kinds of studies.

8.3 Theoretical implications

While the fact that multiple types of video lectures exist is well-known, their effect on learning and engagement has rarely been studied empirically and the benefits and downsides of a lot of these different types of learning videos are not yet clear (Chorianopoulos & Giannakos, 2013; Chen & Wu, 2015). This study adds understanding of PowerPoint Videos and Whiteboard Videos. This understanding can be sorted into learning, guidelines, user experience and acceptance behaviour.

First, regarding learning, the results are especially interesting since it contradicts the results of some other studies (e.g. Wiseman, 2013). The positive effect of Whiteboard Videos on learning is not found in this study. Possible explanations for this difference are given in Section 8.1.2.2.

In addition, no guidelines existed for creating Whiteboard Videos. This study has derived these guidelines from the literature about multimedia learning. These guidelines, which can be found in detail in Section 6.3.2.1, can be used to further investigate Whiteboard Animation Videos. Especially the embodiment principle seems to be an important principle since it can be the reason for the difference in satisfaction between the videos. Furthermore, the coherence principle is important to take into account, since extraneous material is easily included in Whiteboard Animation but can hinder learning.

Furthermore, according to Liu et al. (2009), more research is needed to test the correlation between acceptance behaviour and different types of media. This study adds this information for the media types PowerPoint video and Whiteboard Video.

8.4 Practical implications

The new knowledge can also be used by educational designers in the field of video design in terms of choosing the right kind of video and designing it.

Whiteboard Animations were considered to be better for learning (Wiseman, 2013), but now it is proven that a systematically designed PowerPoint Video is equally effective regarding learning. Only when it is really important that students should have a positive feeling while watching the video, creating a Whiteboard Video can be worth the extra effort and costs. If the choice is to make a Whiteboard Video, the new design guidelines can be followed to systematically make a good video.

In addition, instructional video designers should design their videos, regardless which kind of video, taking into account two goals that are positively correlated with learning. The video should be designed in such a way that it is watched as long as possible. Moreover, the video should support students' belief that they would be successful in performing a task about the video.

8.5 Future research

This study fills the knowledge gap about the effectiveness, acceptance and experience of Whiteboard Animation Videos, however, a lot is still unknown. For future research, it would be interesting to see if the results are different for other topics. In addition, experimenting with the two kinds of videos in a real-life situation, instead of an experimental setting is an interesting future enhancement. For the long run, it would be good to know the results in learning if the students are fully familiar with Whiteboard Animation Videos.

8.6 Conclusion

The aim of this study was to gain insight into the learning and student experiences of students watching Whiteboard Animation Videos and PowerPoint Videos. For this study, guidelines to make/select a good Whiteboard Animation Video are derived from literature about multimedia learning. In addition, a PowerPoint video is designed according to the guidelines of Kosslyn et al. (2012). The experiment showed that there was no learning difference between the two kinds of videos. However, the Whiteboard Video gave more satisfaction. In general, only longer viewing and a higher level of self-efficacy had a significant relationship with learning. In conclusion it can be stated that, in many cases, it is not worth the extra efforts and costs of making a Whiteboard Video if the Power Point presentation is designed properly.

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10. Appendices

Appendix A. Pre-question and Post-test

Pre-question

How would you rate your own knowledge about dieting on a scale of 1 to 10? (with 1 = very bad and 10 = very good)

- o 1
- o 2
- o 3
- o 4
- o 5
- o 6
- o 7
- o 8
- o 9
- o 10

Post-test

1. What makes a diet work best? *remember*

A. How well you stick with the diet;

B. How many other people around you do the diet;

C. If it stimulates you to eat less carbs and fat;

D. If it is simple and the products needed are easy to buy.

(1 point)

Correct: A

2. How many teaspoons of sugar does an average American take per day? *remember*

A. 11 to 15

B. 16 to 20

C. 21 to 25

D. 26 to 30

(1 point)

Correct: B (20)

3. How much kilograms weight loss can daily weighing yourself gain? *remember*

A. 1.1 kg

B. 1.6 kg

C. 2.3 kg

D. 2.8 kg

(1 point)

Correct: C

4. What is the best time to eat proteins? *remember*

A. Breakfast

B. Lunch

C. Midday snack

D. Diner

(1 point)

Correct: A

5. What does PUFA stand for? *remember*

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(1 point)

Correct: Poly unsaturated fatty acids

Also correct: Poly unsaturated fatty acid and/or any spelling mistakes, e.g. 'Polly unsaturated faty acits', 'Poly unsaturated fat acids' and 'Polyunsaturated fatty acids'

Not correct: 'Meervoudig onverzadigde vetzuren' and if one of the words is incorrect.

6. Doctor Mike talks about an 80/20 attitude. Explain what he means with that.

understand

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(2 points)

Correct: If you're making a healthier choice 80 percent of time and your 20 percent is not too high cal. (or an answer with connects the 80% to healthy food and 20% to low call/less-/un-healthy food)

Scoring: 2 points. When only correct, specific food (not healthy/less healthy food in general) is mentioned, give 1 point. When the 80 is connected to healthy food OR the 20 is connected to less healthy food, give 1 point. When mentioning diet instead of healthy/unhealthy food, give no points. When mentioning healthy + correct specific foods for unhealthy, give 2 points.

7. Lowering sugar intake appears to be less effective than some other actions in reducing the risk of progression in diabetes. Name two factors which are more effective.

remember

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(2 point)

Correct: being active (half hour a day) (or sport/exercising/ move more), (five to seven percent) weight loss, eating less saturated fats, and eating more (simple) fibre

Scoring: 1 point per good answer. If more than 2 answers are given, take only a look at the first two. Not correct: eating healthy (too vague)

8. Explain how it is possible that eating more can still give weight loss. *understand*

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(1 point)

Correct:

- If you eat healthier (/low calorie/more fiber) and/*or*
- If you eat food that makes you feel full sooner

Scoring: No partial points possible.

9. Instead of applying it to food, Kim wants to apply the principle of feedback loops to how she spends her money. Give an example of how she can do that and explain how it can help her spend less money.
apply

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(2 points)

Correct: an answer that describes that feedback loops give you an update of your money. For example by using a budgeting app, budgeting diary, checking your credit regularly. Including an explanation that it will give her awareness/an update/information/motivation/ a change in behaviour.

Scoring: 1 point for a correct example, 1 point for a correct explanation

10. Name a problem why someone doesn't move enough and come up with a tweak for this problem. *apply*

```
[empty answer box]
```

(2 points)

<u>Correct:</u> An answer that contains a correct tweak (an idea of starting with small changes / switch something you do a lot)

<u>Scoring:</u> 1 point for a tweak; 1 point if the tweak is a correct solution for the mentioned problem

Appendix B. Questionnaire for Usefulness, Satisfaction, Ease of Use and Self-efficacy

Abbreviation	What?	Questions
U	Usefulness	1, 6, 9, 14, 18, 21
S	Satisfaction	3, 7, 11, 13, 16, 19
E	Ease of Use	4, (5,) 12, 15
SE	Self-efficacy	2, 8, 10, 17, 20, 22

Students had to indicate to what extent they agreed/disagreed with the following statements on a scale of 1 (strongly disagree) to 7 (strongly agree).

Whiteboard Video condition

U	1. Whiteboard videos like these are useful for study.
SE	2. I have a clear memory of the main message of the whiteboard video.
S	3. It was a gratifying experience to view the video.
E	4. I quickly lose track with a whiteboard video. [Reverse coding]
E	5. A whiteboard video facilitates studying a topic. [Deleted after analysis]
U	6. This type of video is handy for students.
S	7. Viewing the whiteboard video was a valuable experience.
SE	8. I can write a good summary of the whiteboard video.
U	9. Whiteboard videos like this are important in education.
SE	10. I can recall most of the details in the whiteboard video.
S	11. The whiteboard video was a pleasure to behold.
E	12. Whiteboard videos require less effort to follow than video-recorded lectures.
S	13. I enjoyed viewing the video.
U	14. Students benefit from having whiteboard videos available.
E	15. Whiteboard videos are easy to use.
S	16. This video was boring. [Reverse coding]
SE	17. I understood the main idea(s) of the whiteboard video.
U	18. Whiteboard videos nicely complement study books.
S	19. I was content with what the video had to offer me.
SE	20. I am confident that I will do well on a knowledge test on the whiteboard video.
U	21. Whiteboard videos are a useful resource.
SE	22. I can remember the content of the whiteboard video quite well.

PowerPoint Video condition

U	1. PowerPoint videos like these are useful for study.
SE	2. I have a clear memory of the main message of the PowerPoint video.
S	3. It was a gratifying experience to view the video.
E	4. I quickly lose track with a PowerPoint video. [Reverse coding]
E	5. A PowerPoint video facilitates studying a topic. [Deleted after analysis]
U	6. This type of video is handy for students.
S	7. Viewing the PowerPoint video was a valuable experience.
SE	8. I can write a good summary of the PowerPoint video.

U	9. PowerPoint videos like this are important in education
SE	10. I can recall most of the details in the PowerPoint video.
S	11. The PowerPoint video was a pleasure to behold.
E	12. PowerPoint videos require less effort to follow than video-recorded lectures.
S	13. I enjoyed viewing the video.
U	14. Students benefit from having PowerPoint videos available.
E	15. PowerPoint videos are easy to use.
S	16. This video was boring. [Reverse coding]
SE	17. I understood the main idea(s) of the PowerPoint video.
U	18. PowerPoint videos nicely complement study books.
S	19. I was content with what the video had to offer me.
SE	20. I am confident that I will do well on a knowledge test on the PowerPoint video.
U	21. PowerPoint videos are a useful resource.
SE	22. I can remember the content of the PowerPoint video quite well.