The Effects of System- and Learner-Control Pacing in Conceptual and Procedural Educational Videos

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Abstract

Videos are playing an essential role in learning, causing research on video-based learning to increase tremendously. Empirical evidence has shown multiple advantages for learning when it comes to using learner- and system-control pacing for video watching. This study investigated the effects of learner- and system-control on mental effort, using both a conceptual and procedural video topic. Moreover, the usage of the control features and the effects on engagement and learning outcomes were investigated. University students (n=80) participated in this study and were allocated to groups differing in learner-control, system-control and segmentation using a between-subject design with repeated measures. The presented study resulted in statistically significant differences on gain scores for procedural knowledge development in favour of segmentation with learner-control compared to learner-control, segmented system-control and continuous system-control. This finding suggests that implementing segmentation with learner-control in educational videos with a procedural topic will result in better learning outcomes, but not for educational video with a conceptual topic.

Keywords: pacing, learner-control, system-control, segmentation

Contents

Introduction

Videos represent a fast-growing part of the total amount of internet content and media content that is currently available (Matthews, 2018). Many of these videos are educational or instructional videos which focus on learning purposes, and recently an increasing amount of research is on video-based learning (Giannakos, 2013; Cojean & Jamet, 2017). Effective implementation of video-based learning requires the usage of adequate guidelines for the making of educational or instructional videos. The most commonly used guidelines for the making of educational and instructional videos are for example the multimedia design principles by Mayer (2014), the use of minimalism for instructional design (van der Meij & Carroll, 1996), the four-component instructional design model (Merriënboer & Kester, 2005) and the design guidelines by van der Meij & van der Meij (2013) for software training.

Pace-manipulation is one of the design guidelines proposed by these models to improve the effectiveness of video-based learning. Advantageous effects for learning have continuously been shown on studies on pace-manipulation of videos, for example, the use of learner- and segmented system-control pacing. Empirical evidence has shown a positive impact of learner-control on various measures: mental effort, skill acquirement, high scores on retention and transfer. (Schwan & Riempp, 2004; Betrancourt, 2005; Hasler, Kersten & Sweller, 2007; Stiller & Zinnbauer, 2011; Tabbers, 2002).

Several empirical studies have also repeatedly found that the use of segmented system pacing enhances learning, it allows for more improved navigation and lowers difficulty ratings (Biard, Cojean, & Jamet, 2018; Hasler, Kersten & Sweller, 2007; Spanjers, van Gog & Van Merriënboer, 2010, 2011; Spanjers, van Gog, Wouters, & van Merriënboer, 2010). These studies do experience some setbacks; some fail to find a positive effect of learner-control for learners with low levels of prior knowledge (Biard, Cojean & Jamet, 2018; Cojean & Jamet, 2017, 2018; Wouters, Tabbers & Paas, 2007), while others found that segmented system-control might harm learning for learners with high levels of prior knowledge (Spanjers, van Gog & Van Merriënboer, 2010, 2011; Spanjers, van Gog, Wouters, & van Merriënboer, 2010).

Furthermore, studies contrasting learner- with system-control mainly concentrate on conceptual knowledge development (Hasler, Kersten & Sweller, 2007; Höffler & Schwartz, 2011), only recently there has been a few who have also been concentrating on procedural knowledge development (Biard, Cojean & Jamet, 2018; Cojean & Jamet, 2017, 2018).

The proposed study will focus on contrasting learner- with system-control using both a conceptual and procedural video topic. Perceived mental effort between learners using learner- and system-control pacing will be studied. Moreover, the focus will also be on engagement, the so-called usage of the control features, since only a handful of researchers studied this phenomenon (e.g., Hasler, Kersten & Sweller, 2007; Schwan & Riempp, 2004; Tabbers & Koeijer, 2009). Lastly, this study will let learners perform a pre- and post-retention and transfer assessment.

Research Context

Learner-control

There is a clear distinction between two types of pace manipulations: learner- and system-control pacing (Biard, Cojean & Jamet, 2018; Betrancourt, 2005). Learner-control pacing gives learners the possibility to manipulate the pace of a video with a ‘‘slider bar” or simply a ‘‘stop/pause” and ‘‘play” button, as found on any video player (Betrancourt, 2005). With this, the learners can actively decide when to start, stop, rewind or fast-forward the pace of a video. The most commonly applied learner-control actions are starting, pausing, stopping, fast-forwarding and replaying. The learner-control principle refers to designs that manipulate the temporal dimension of a video. Betrancourt (2005) describes the principle as follows: “the information depicted in the animation is better comprehended if the device gives learners the control over the pace of the animation” (p. 294).

Learner-control has several advantages. Learners decide when to perform an action. They can stop to reflect and start with the next segment or move video-play forward when they are satisfied with understanding. With this, they can adjust the information flow to their cognitive needs and abilities during video viewing (Spanjers, Wouters, van Gog & Merriënboer, 2010, 2012). For instance, learners can slow down the pace of the learning material depending on the difficulty of understanding, and they can replay the video when they have missed information. Learner-control features can give learners the ability to select relevant information, the ability to organise the incoming information and the ability to integrate incoming information with the existing knowledge. This is known by Mayer (1999) as the Selecting-Organising-Integrating (SOI)-model of knowledge construction for learning.

In short, learner-control can overcome perceptual and conceptual limitations because learners can manipulate the continuous flow of the information in a video, which can make

learners process the new information better and integrate it progressively in their mental model (Mayer, 2005).

Empirical evidence showed the superiority of learner-control versus continuous system-control on various measures: less mental effort while learning (Stiller & Zinnbauer, 2011), less time on acquiring a skill (Schwan & Riempp, 2004), and higher scores on tasks of retention and transfer (Betrancourt, 2005; Hasler, Kersten & Sweller, 2007; Stiller & Zinnbauer, 2011; Tabbers, 2002).

Some empirical studies have failed to find a positive effect of learner-control when being compared to segmented system-control (Biard, Cojean & Jamet, 2018; Cojean & Jamet, 2017, 2018 Wouters, Tabbers & Paas, 2007). According to Wouters, Tabbers and Paas (2007), learner-control may prove problematic for learners with low levels of prior knowledge, who do not know where or when to apply learner-control. Especially for low prior knowledge learners, an instruction to actively segment the video may be an additional task that requires cognitive capacity that distracts them from learning (i.e., extraneous load; Mayer, 2005; Schwan & Riempp, 2004). Therefore, learner-control may only be beneficial for learners with higher levels of prior knowledge.

System-control

System-control gives learners no tools for pacing the video. Video-play starts and ends automatically without any action performed by the learner (Scheiter, 2014). There are two types of system-control pacing: continuous system-control and segmented system-control. Continuous system-control is when the video plays without any disruptions implemented by the video-designer. Segmented system-control is when the video has been pre-segmented for viewing by the video-designer — this consist of dividing the video into several clips or within-video sections containing a definite beginning and end.

The most common instructional features that are used for segmenting a video are the inclusion of pauses and labels (Brar & Meij, 2017). Pauses are short, two to five second breaks within a video. During a pause, there is no new (visual or auditory) information, and in some occasions, the screen dims to a black colour, which gives the learner time to digest the presented information. A label summarises the critical point of a short video section. All labels together give a basic overview of the content of a clip which should promote retention (Brar & Meij, 2017).

A segment of time at a given location that is conceived by a learner or designer to have a clear beginning and an end is known as an "event" (Kurby & Zacks, 2008). The event segmentation theory describes the processes underlying mental segmentation (Zacks, 2010). It assumes that learners form event models in working memory from incoming sensory information and prior knowledge. Based on these models, learners predict what will happen and compare these predictions against what actually happens. When the information contained in animation is (partly) familiar to learners, they can deal with its transience (Zacks, 2010). If there is a severe discrepancy, the learner will need to create a new event model. Here, a so-called event boundary is distinguished (Zacks, 2010). Physical changes in the information shown, such as changes in movements, speed, as well as structural changes, such as sub-goal completion and initiation, lead to a decrease in predictability of the new incoming sensory information and, therefore to the distinction of event boundaries (Kurby & Zacks 2008; Zacks, 2010; Gold, Zacks & Flores, 2017).

Empirical studies have continuously proven that segmented system-control is superior to continuous system-control (Mayer & Chandler, 2001; Boucheix & Guignard, 2005; Moreno, 2007; Spanjers, van Gog & Van Merriënboer, 2010; Spanjers, van Gog, Wouters, & van Merriënboer, 2012). A video with a continuous flow of information is very likely to generate a very high cognitive load (Sweller, van Merrienboer, & Paas, 1998), which will most likely result in a low learning outcome.

Several empirical studies have repeatedly found that segmentation enhances learning (Spanjers, van Gog & Van Merriënboer, 2010, 2011; Spanjers, van Gog, Wouters, & van Merriënboer, 2010). Segmented videos also allow for more improved navigation (Biard, Cojean, & Jamet, 2018; Hasler, Kersten & Sweller, 2007; Wouters, Tabbers & Paas, 2007) and lower difficulty ratings (Spanjers, van Gog, Wouters, & van Merriënboer, 2012; Spanjers, Wouters, van Gog, & van Merriënboer, 2011). Segmentation can also help learners conceptualise the functioning of a system, concept or procedure and aims at managing essential processing and can support the retention process (Mayer, 2014). Segmentation has been a highly used design guideline for the making of instructional videos and have had many successes (Spanjers, van Gog & Van Merriënboer, 2010, 2011; Spanjers, van Gog, Wouters, & van Merriënboer, 2010; Biard, Cojean, Jamet, 2018; Cojean & Jamer, 2017, 2018). Previous research has mainly focused on contrasting learner-control with continuous- or segmented system-control. Research analysing the effects of a video which combines segmented system-control and learner-control has rarely been studied, only very recently by Biard, Cojean & Jamet (2018). Their recent study concluded that the segmented interactive

format for procedural learning resulted in higher scores when compared to a non-interactive and interactive format. Furthermore, in their study no significant differences between conditions were found for recall. Since this phenomenon has barely been studied, there is a need to replicate parts of this study to see if the same results can be found.

Engagement

Engagement refers to the viewing of the video and the usage of the control-features. Research on learner-control rarely studied the usage of the control features. Despite its obvious importance, less than a handful of studies (e.g., Hasler, Kersten & Sweller, 2007; Schwan & Riempp, 2004; Tabbers & Koeijer, 2009) have assessed this use. These studies concluded that (1) just because these features are available does not mean that learners will use them (Hasler, Kersten & Sweller, 2007), (2) the learner-control features are mainly used when the tasks to be performed are difficult (Schwan & Riemp, 2004) and (3) Tabbers & Koeijer (2009) found out that learners who used the learner-control features more, also learned more. These studies mainly based their results on the retention and transfer scores of each learner, but the mental effort of the learner was not measured. There is, therefore, also a need to measure the perceived mental effort of the learner while video-watching, to gain more insight on the impact of extraneous load while using the learner-control features.

Conceptual and procedural knowledge

Instructional videos mainly focus on two types of knowledge development; conceptual and procedural knowledge development, which are dependent on the topic of the video. Some video topics mainly cover only conceptual or procedural knowledge, while some video topics cover both conceptual and procedural knowledge.

Researchers have several definitions of procedural knowledge. Hiebert and Leferve (1986) say that procedural knowledge is “to know how something happens in a particular way”. Rittle-Johnson and Wagner (1999) define it as “action sequences for solving problems”. Barr, Doyle et al. (2003) says it is “like a toolbox; it includes facts, skills, procedures, algorithms or methods". More recently Arslan (2010) defines it as “learning that involves only memorizing operations with no understanding of underlying meanings”. In sum, procedural knowledge focuses on the learning of ‘how’, for example how to gain a new skill, how to perform a procedure and how to solve problems. Some examples of procedural video topics are, how to fix a bicycle tire and how to put a piece of furniture together.

In contrast, researchers define conceptual knowledge as follows. Hiebert and Leferve (1986) say that conceptual knowledge is “to know why something happens in a particular way”. Rittle-Johnson and Wagner (1999) define it as “explicit or implicit understanding of the principles that govern a domain and of the interrelations between pieces of knowledge in a domain”. Barr, Doyle et al. (2003) says it is “ideas, relationships, connections or having a ‘sense’ of something". Arslan (2010) defines it as “learning that involves understanding and interpreting concepts and the relations between concepts”. In sum, conceptual knowledge focuses on the learning of the ‘what’ and ‘why', for example, to understand the concepts and relationships of a domain. Some examples of conceptual video topics are, what is the internet, why do we eat and what are planets.

Hegarty (2014) found in the individual studies included in a meta-analysis comparing learning from videos and static visualisations of Hofler and Leutner (2007) that only 21 of 76 comparisons revealed a significant advantage of video, and effect sizes were higher when the topic to be learned was procedural than when the topic was conceptual. Studies by Plaisant and Schneiderman (2005) and by Van der Meij & Van der Meij (2013) about guidelines for the making of educational videos advice practitioners to focus on conveying procedural information. They argue that when learners consult a “how to” video, all of the information must focus on task completion which is procedural information. Conceptual information should only be presented when it contributes significantly to the learner’s task understanding (Van der Meij & Van der Meij, 2013). In sum, the effects of video-based learning are higher when the topic of the video is procedural rather than conceptual.

There is little to no research comparing conceptual and procedural videos when it comes to learning by using system- and learner-control. Research contrasting learner- with system-control on the effects of conceptual and procedural knowledge has also rarely been studied and the few who have, mainly concentrate on conceptual knowledge development (Hasler, Kersten & Sweller, 2007; Höffler & Schwartz, 2011).

Experimental design and research questions

This study explores the effect of four types of pace-manipulations that can be implemented in a conceptual and procedural educational video; continuous system-control, segmented system-control, learner-control and segmentation with learner-control. This study mainly explores the effects of using these types of pace-manipulations during video-watching on mental effort of participants and retention and transfer in the gain scores.

A between-subjects design with repeated measures is implemented, participants watched two educational videos, one covering a conceptual topic and a procedural topic. The four conditions in the study were: control condition which did not include learner-control features and no added pauses, also known as a continuous system-control (video with continuous system-control; abbreviated 'CC'), learner-controlled (video with learner-control, abbreviated 'LC'), segmentation without learner-control, also knows as a segmented system-control (segmented video with no control, abbreviated 'SNC') and segmentation with learner-control (segmented video with learner-control abbreviated 'SLC'). The experiment design is illustrated in Table 1. All participants were randomly assigned to one of the four conditions.

Table 1

Between subject design with repeated measures

		First Video **Conceptual**		Second Video **Procedural**
Control Condition: **Continuous System-control and no learner-control**	(n=20)	CC	⟶	CC
Experimental Condition1: **Learner-control**	(n=20)	LC	⟶	LC
Experimental Condition2: **Segmentation and no learner-control**	(n=20)	SNC	⟶	SNC
Experimental Condition3: **Segmentation and learner-control**	(n=20)	SLC	⟶	SLC

The following research questions guided this study.

Research question 1: What is the effect of system- and learner-control on engagement?

Engagement in this study refers to coverage, pauses and replays. Coverage is the percentage of the time of the video, which was put in play, this measures how much content of the video was watched. Pauses refers to the number of pauses taken in the learner-control conditions (LC and SLC). Replays refers to the **percentage** of the time of the video, which

was put in replay, this measures how much content was re-watched in the learner-control conditions.

Biard, Cojean & Jamet (2018) compared an interactive with a segmented-interactive group, similar to the LC and SLC groups, they observed that the number of pauses taken were the same in both conditions. This relationship between engagement and learner-control video types have not been studied by many researchers. The few studies who have studied this relationship conclude that the availability of control features does not guarantee the use of them (Hasler, Kersten & Sweller, 2007) and that control features are mainly used when the task to be performed is difficult (Schwan & Riemp, 2004). It is expected that learners in both LC and SLC will make use of pauses and replays, but there will not be significant differences between LC and SLC.

Research question 2: What is the effect of system- and learner-control on mental effort?

Mental effort refers to the participant's perceived cognitive load or in other words the experienced mental difficulty to keep up with or to be able to remember all the information in the video while watching the video. A video with a continuous flow of information is very likely to generate a very high cognitive load (Sweller, van Merrienboer, & Paas, 1998), which in most cases will result in a low learning outcome. Several studies have shown that segmentation lowers difficulty ratings (Spanjers, van Gog, Wouters, & van Merriënboer, 2012; Spanjers, Wouters, van Gog, & van Merriënboer, 2011). Stiller & Zinnbauer (2011) compared learner-control and continuous system-control and found that learner-control resulted in less mental effort while learning. Thus, it is expected that learners in LC and SLC will yield lower mental effort while video-watching compare to learner in CC and SNC.

Research question 3: What is the effect of system- and learner-control on conceptual and procedural knowledge development on retention and transfer?

Studies comparing learner-control, continuous and segmented system-control, have resulted many times in learner-control yielding higher scores on tasks of retention and transfer (Betrancourt, 2005; Hasler, Kersten & Sweller, 2007; Stiller & Zinnbauer, 2011; Tabbers, 2002). Tabbers & Koeijer (2009) found out that learners who used the learner-control features more, also learned more. Studies have also resulted in segmented system-control being superior to continuous system-control yielding higher scores of retention (Mayer & Chandler, 2001; Boucheix & Guignard, 2005; Moreno, 2007; Spanjers, van Gog & Van Merriënboer, 2010; Spanjers, van Gog, Wouters, & van Merriënboer, 2012). Biard, Cojean & Jamet (2018) recently observed that segmented interactive video for procedural

learning resulted in higher scores when compared to a non-interactive and only interactive video. Thus, it is expected that SLC will yield higher scores than LC, SNC and CC for both retention and transfer. While LC will perform better than SNC, and SNC performing better than CC. And procedural knowledge development will yield higher scores for SLC, LC, SNC and CC compared to the scores for conceptual knowledge development.

Method

Participants

A total of 80 university students took part in this research after ethical approval was granted from the Ethics Committee for the Behavioural Science faculty at the University of Twente. Convenience sampling (Muijs, 2004, p.40-41) was employed by inviting students to participate via posts on social media. In exchange for their participation, Bachelor of Psychology participants received 1.25 credits from the SONA Experiment Management System. Of the 80 participants, there were 21 (26.25%) men, 56 (70%) women, one who identified as other, aged 18 to 30 years old (M = 24.56, SD = 2.859). The participants were 33 (41.25%) native Dutch speakers, 23 (28.75%) native English speakers, and 22 (27.50%) were other language speakers. The participants were following different educational degrees: 36 (45%) were following a bachelor's degree, 4 (5%) were following a pre-master's degree, 33 (41.25%) were following a master's degree, 5 (6.41%) were following a PhD. The participants were following their degrees in different fields: 15 (18.75%) in health sciences, 22 (27.50%) in liberal arts, 9 (11.25%) in educational sciences, 9 (11.25%) in technical sciences, 23 (28.75%) in business & management. Two participants choose not to indicate their demographic information but did participate in the experiment.

Educational Videos

Conceptual Video. The first educational video covered a conceptual topic which explained various aspects of sleep, covering as much of the science of sleep. The video consisted of 5 segments, (1) circadian rhythm & your brains clock, (2) why do we need sleep and what happens without it, (3) how can I fall asleep?, (4) when sleep turns against us and (5) can you get too much sleep? The video was created by using a video made available by 'Scishow' a channel on YouTube: The Science of Sleep (https://www.youtube.com/watch?v=aLNhfVCa5qY). Any unnecessary content such as

advertisements were removed. This video was chosen for its duration covering a lot of aspects on one conceptual topic, also because the video followed several instructional video design guidelines. For example; labeling was used, at the beginning of each segment the topic that was going to be discussed was shown on the screen for 1 second, the use of highlighting was implemented, key words would pop up while the narrator was talking. A label summarises the critical point of a short video section. All labels together give a basic overview of the content of a clip which should promote retention (Brar & Meij, 2017). The video consisted of the 5 segments mentioned above, segment 2 was the longest, therefore chosen to be split into two sub-segments, so for this experiment the video consisted of 6 segments, each segment were roughly 4 minutes long. In the segmented system-controlled conditions (SNC and SLC), pauses of 2 seconds were added at the end of each segment of the video. The total duration of the video without pauses was 24:37 which was used in CC and LC. The total duration of the video with pauses was 24:56. In Figure 1 it is illustrated which video was used in which condition.

Procedural Video. The second educational video covered a procedural topic which explained and demonstrated how to format tables and figures using APA-formatting style. The video consisted of 4 topics, (1) how to make an APA-style table, (2) how to add a caption to the table and how to add an in the text reference, (3) how to add a caption to a graph and how to add a reference in the text, (4) how to update in text references when changes are made to the captions. The video was created by using a video made available by Steve Kirk a teacher of Research Writing in English who frequently uploads videos of his classes on his YouTube channel: https://www.youtube.com/watch?v=axjUhtr6Sz8&t=1s. The video was made in a clear style, consisted of an audio narration accompanied by visuals. This video was chosen based on the paste of the narrated audio, the narration was in sync with the actions displayed, the video was also simple and did not use visuals which would distract the viewer from the main goal. The audio of the video was used, but the visuals had to be remade since the visuals were not in English, so the remade visuals were in English and made by the researcher of this study which is also a video-designer. The video consisted of 4 topics, each topic was covered in roughly 2 minutes, at the end of each topic a pause of 2 seconds was added, during these two seconds the screen dimmed to a black screen. The total duration of the video without pauses was 7:23, this video was used in CC and LC. The total duration of the video with pauses was 7:36, this video was used in SNC and SLC. In Figure 1 it is illustrated which video was used in which condition.

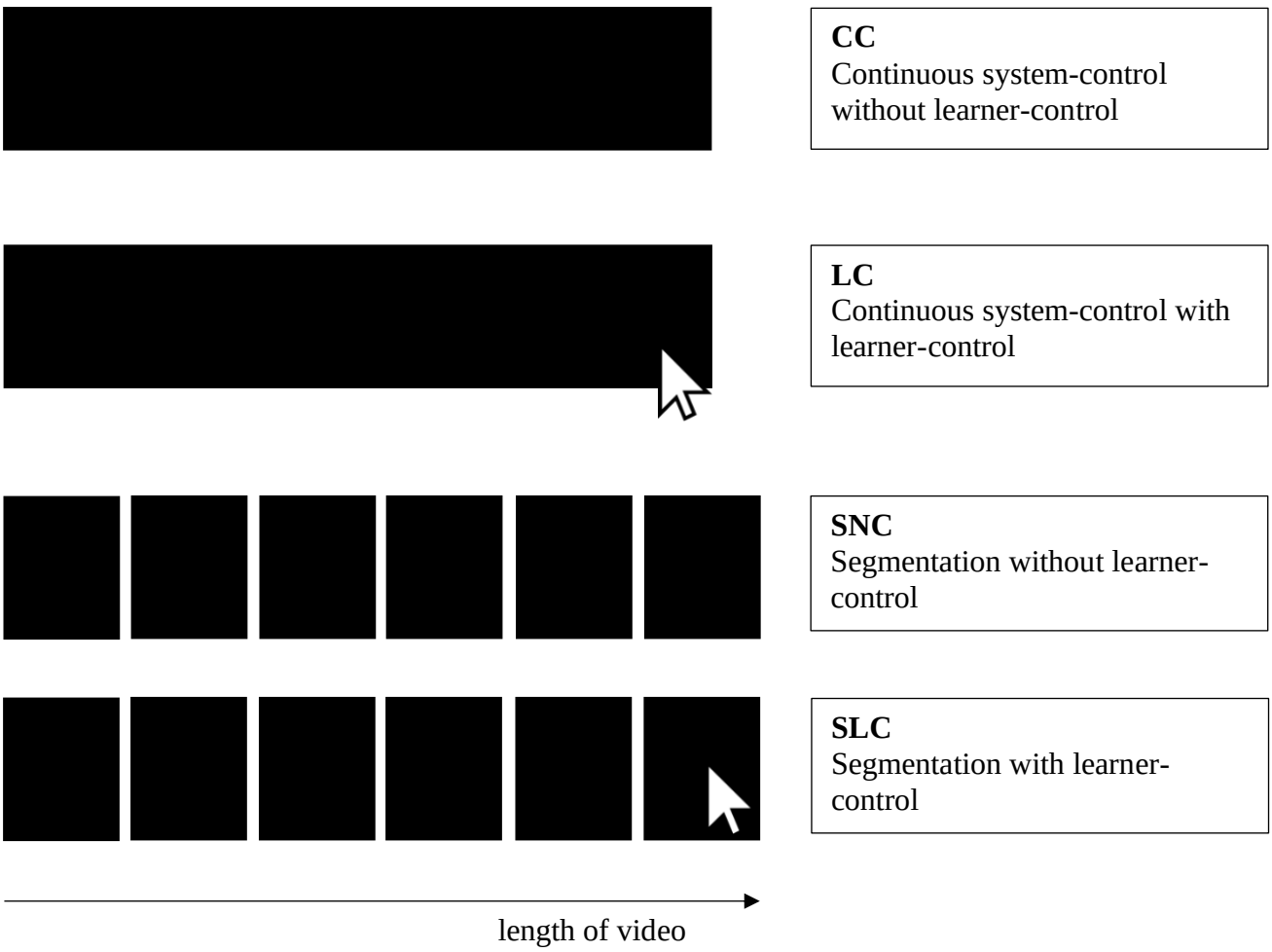


Figure 1. Schematic overview of the type of videos used

Measurement Instruments

Website. A dedicated website using the educational platform Graasp (Next-Lab, 2018), guided the participants through the experiment and gave access to all resources (e.g., videos, Word files, questionnaires). The participants could log in using a 'nickname', watched the video segments, completed a demographic and mental effort questionnaire and pre- and post-test.

User logs. The Graasp (Next-Lab, 2018) platform was used to administer the study and recorded the participants' video viewing activities: the seconds the video segments were played, paused or re-watched. The user log data was used to calculate participants' video coverage and replay percentages and number of pauses taken. Coverage consisted of the total number of seconds a video segment was put in play mode at least once. The participant's

unique play time and percentage was registered. Replays indicated the percentage of time the video was re-watched. To calculate the percentage of replays, the sum of play video time was registered. In LC and SLC, participants were allowed to replay the video, this replay time was calculated by subtracting the sum play time with the unique play time. Pauses indicated the number of pauses registered while video watching. This is when the video was brought to a full stop and started playing again, once the participant decided to continue video play.

Mental effort. The cognitive load perceived while watching the video was measured by letting the participants rate their mental effort after video watching by filling in a questionnaire, a scale between one 'very, very low' and nine 'very, very high' has been given for rating. The questionnaire has been based on the one developed by Paas, Merriënboer & Adam (1994), which included questions that asked the participants to rate the degree of mental difficulty and effort experienced while video watching. The first mental effort questionnaire consisted of 6 questions to rate, participants had to rate their mental effort per segment. The second mental effort questionnaire consisted of 4 questions to rate, participants had to rate their mental effort per segment (see Appendix A).

Pre-test. The pre-test on sleep consisted of 6 open-questions, one question per segment of the video. The questions were about the participants daily routine, for example question 2 and 3 were 'During which part of a 24-hour day do we tend to be at our cognitive best and when is our desire to sleep the highest?' and question 6 was 'What are two things you should not do before deciding to go to sleep which will not allow you to fall asleep?' (see Appendix B for a full list of sleep pre-test questions).

The pre-test on APA consisted of 4 questions. Two questions were on what they think APA is, question 2 was 'What are the main formatting requirements on the title page when following the APA-style?' and for the two other questions participants were given a wrongly APA-formatted table and figure, they had to then indicate which parts of the table and figure were not formatted using APA (see Appendix C for a full list of APA pre-test questions).

A coding scheme was developed and used to score the pre-test responses for sleep and APA (see Appendix D). The maximum pre-test score on sleep was 12 points and APA was 13 points. Full points were given for complete answers, and no points were given for incorrect or missing answers. Raw scores for each participant were summed up. An independent rater scored 100% of the pre-test question responses (n=80) resulting in an inter-rater reliability of $\kappa = .89$ which indicated that there is a strong agreement between raters.

Post-test. The post-test on sleep consisted of 16 questions. The topics of the questions were in the same order of when the topics were covered in the video, there were 15 open-questions and one multiple choice question. There were 10 short questions where 1 point could be obtained if answered correctly, for example ‘What is sleep paralysis?’ and ‘Give a reason why some people sleep-walk?’. For the remaining 6 questions 2 or 3 points could be obtained, a few examples of these questions are ‘Which three daily necessities are affected by the Circadian Rhythm?’ and ‘Why do we need sleep? Give three reasons why people need sleep’ (see Appendix E for a full list of sleep post-test questions).

The post-test on APA consisted of 7 questions. The post-test consisted of two conceptual retention questions, three procedural retention questions. The procedural retention questions were tasks where the participants were asked to format a table and a figure and make in-text references. The two last questions of the post-test were procedural transfer questions, were participants were asked to create a list of tables and figures, this topic was not covered in the video, but participants could use the knowledge they have learned from the video on how to do in-text references, to create these lists (see Appendix F for a full list of APA post-test questions).

A coding scheme was developed and used to score the post-test responses on sleep and APA (see Appendix G). The maximum post-test score on sleep was 26 points and APA were 14 points. Full points were given for complete answers and no points were given for incorrect or missing answers. Raw scores for each participant were summed up. An independent rater scored 100% of the post-test question responses (n=80) resulting in an inter-rater reliability of (κ =.92), which indicated a strong to almost perfect agreement between raters.

Gain scores. The improvement (gain) from pre-test to post-test were computed for each participant by subtracting each participants’ pre-test score from their post-test score. A positive gain score indicates that the post-test score was greater than the pre-test score, a negative gain score indicates that the post-test score was less than the pre-test score.

Procedure

The experiment was fully administered via the Graasp platform. Participants followed the experiment from wherever they were located, they only needed an Internet connection, a laptop and earphones. Participants were randomly assigned into the four conditions and they received the same procedure (see Appendix H); they worked individually and were asked to complete the experiment in one sitting.

Introduction. In an email, all participants were asked to sign in to the Graasp platform designated for their condition using a link (see Appendix I). On the Graasp platform, participants were: a) given information about the study procedure; b) informed their participation was voluntary and that they could stop participating at any time; c) asked to consent to their participation; d) asked to provide demographic information about their age, gender and study program.

The following three sections were repeated twice, one covering the conceptual topic, the video on sleep and one covering the procedural topic, the video on APA.

Pre-test. After the demographic questionnaire, participants were asked to fill in a short pre-test where they were not allowed to search for information online or ask for help.

Video Viewing. After the pre-test, participants were instructed to begin watching the first video in the next Graasp tab. Reminders were placed above each video indicating that the participants should watch the video in full, they could use the video controls to pause and re-watch the content any time only in condition LC and SLC. Participants in CC and SNC were informed they had to watch the video in one-sitting without pausing and re-watching.

Mental effort questionnaire. After watching the first video, participants were instructed to fill in how difficult it was to remember the information in the video per segment.

Post-test. To conclude their participation in the study, participants were asked to complete a post-test.

End. Lastly, participants were thanked and asked to contact the researcher for further instruction on obtaining their SONA credits when applicable.

Data analysis

All data was quantitative. Assumption testing revealed non-normal distributions for all data. Therefore, comparisons involved non-parametric tests (i.e., Kruskal Wallis, Wilcoxon, Mann-Whitney). For the Mann-Whitney *U* test, the exact significance was reported. Due to missing data, the degrees of freedom slightly varied across measures. An alpha level of 0.05 as statistically significant and 0.01 as highly statistically significant was set for all statistical tests. A Bonferroni correction was set for repeated measures, the *p*-value must be $p \leq 0.025$ for statistically significant results.

No associations were found between the demographics and the conditions. No association was found between age and conditions ($X_2(33) = 43.97$, $p = 0.096$), gender and conditions ($X_2(6) = 4.88$, $p = 0.560$), nationality and conditions ($X_2(6) = 4.82$, $p = 0.567$), educational level and conditions ($X_2(9) = 8.50$, $p = 0.485$) and educational degree and conditions ($X_2(12) = 17.16$, $p = 0.144$).

The constructs of the two mental effort questionnaires were found to be highly reliable: questionnaire 1 on sleep ($a = 0.90$) and questionnaire 2 on APA ($a = 0.94$).

Correlation coefficient analyses using the Spearman rank order were conducted to explore if all independent variables, coverage, replay, pauses, mental effort, influenced gain scores.

Results

Coverage. The length of video 1 in CC and LC was 1477 seconds and the length of video 1 in SNC and SLC was 1496 seconds. The length of video 2 in CC and LC was 443 seconds and the length of video 2 in SNC and SLC was 456 seconds. Table 2 presents the data for unique play for both videos. In all conditions more than 60% of the first video were viewed. In all conditions more than 50% of the second video were viewed. There were no significant differences between conditions on coverage of the first video on sleep, H (3, N = 80) = 7.65, p = 0.053). There were also no significant differences between conditions on coverage of the second video on APA, H (3, N = 80) = 4.51, p = 0.21).

Table 2

Mean unique play rates (percentages) and standard deviation per condition and video type.

	Video 1: Sleep		Video 2: APA	
Condition	M	SD	M	SD
CC *(n=20)*	1155.0 (78.2%)	582.5	320.6 (74%)	185.2
LC *(n=20)*	1136.8 (75.9%)	696.6	299.8 (69.2%)	214.6
SNC *(n=20)*	1340.0 (90.7%)	397.3	354.4 (77.7%)	158.8
SLC *(n=20)*	960.7 (64.2%)	625.2	232.5 (50.9%)	234.6
Total (n=80)	*1147.9*	*590.4*	*301.8*	*201.6*

Replay. Only in the two learner-controlled conditions LC and SLC, participants were allowed to use the replay feature. No participants replayed the video while watching the first video. Table 3 presents the data for replay time for both videos. There were no significant differences between conditions on replay for the second video, U = 199, z = -0.04, p = 0.97.

Table 3

Mean replay time and standard deviation per learner-controlled condition and video type.

	Video 1: Sleep		Video 2: APA	
Condition	M	SD	M	SD
LC *(n=20)*	0	0	9.65	43.2
SLC *(n=20)*	0	0	2.45	11.0
Total (n=40)	*0*	*0*	*3.03*	*22.2*

Pauses. Only in the two conditions, LC and SLC were participants allowed to pause the video. Table 4 presents the data for the number of pauses taken. There were no significant differences for pauses between conditions for the first video, $U = 180$, $z = -0.61$, $p = 0.54$. There were also no significant differences for pauses between conditions for the second video, $U = 168$, $z = -1.02$, $p = 0.31$. During video-watching of the first video in LC 10 out 20 participants paused the video and in SLC 9 out of 20 people paused the video at least once. During video-watching of the second video in LC 8 out of 20 participants paused the video and in SLC 6 out of 20 participants paused the video at least once.

Table 4

Mean pause frequency and standard deviation per learner-controlled condition and video type.

	Video 1: Sleep		Video 2: APA	
Condition	M	SD	M	SD
LC *(n=20)*	1.65	3.79	0.85	1.35
SLC *(n=20)*	0.65	0.88	0.35	0.59
Total (n=40)	*0.58*	*2.02*	*0.30*	*0.80*

Mental effort sleep. Table 5 presents the data for the mental effort per segment per video perceived during the first video. For all segments of mental effort for the video of sleep there were no significant differences between conditions: ME1 (H (3) = 3.315, $p = 0.35$), ME2 (H (3) = 3.30, $p = 0.35$), ME3 (H (3) = 2.30, $p = 0.51$), ME4 (H (3) = 3.27, $p = 0.35$), ME5 (H (3)=1.14, $p = 0.77$) and ME6 (H (3) = 2.90, $p = 0.41$).

Table 5

Mean mental effort per segment of the first video and standard deviation per condition.

	Video 1: Sleep											
	ME1		ME2		ME3		ME4		ME5		ME6	
Condition	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
CC *(n=20)*	5.70	2.03	5.30	2.11	5.50	1.99	5.25	2.12	5.05	2.31	5.15	2.37
LC *(n=20)*	5.65	2.30	5.95	1.47	5.75	1.52	5.20	1.67	4.45	2.16	4.05	2.24
SNC *(n=20)*	5.35	1.87	5.25	1.55	4.95	1.64	4.85	1.76	4.45	1.79	4.40	2.11
SLC *(n=15)*	6.53	1.25	6.00	1.65	5.20	2.11	4.14	1.66	4.60	1.68	4.40	2.17
Total (n=75)	*5.76*	*1.94*	*5.60*	*1.72*	*5.36*	*1.80*	*4.92*	*1.83*	*4.64*	*2.00*	*4.51*	*2.22*

Note. Scale values range from 1 to 9 with higher values indicating a high mental effort.

Mental effort APA. Table 6 presents the data of perceived mental effort of the second video per segment. For all segments of mental effort for the video of APA there were no significant differences between conditions: ME1 (H (3) = 1.40, p = 0.71), ME2 (H (3) = 1.83, p = 0.61), ME3 (H (3) = 2.72, p = 0.44) and ME4 (H (3) = 4.83, p = 0.18).

Table 6

Mean mental effort per segment of the second video and standard deviation per condition.

	Video 2: APA							
	ME1		ME2		ME3		ME4	
Condition	M	SD	M	SD	M	SD	M	SD
CC *(n=17)*	4.88	2.42	4.94	2.49	4.65	2.52	4.07	2.28
LC *(n=19)*	4.84	1.83	4.84	1.71	4.79	1.93	4.79	2.42
SNC *(n=20)*	5.10	2.10	4.89	2.05	4.45	2.31	4.37	2.41
SLC *(n=15)*	5.69	1.80	5.77	1.69	5.62	1.56	5.69	1.38
Total (n=71)	*5.09*	*2.04*	*5.06*	*2.01*	*4.81*	*2.14*	*4.68*	*2.24*

Note. Scale values range from 1 to 9 with higher values indicating a high mental effort.

Total mental effort. Table 7 presents the average of the total mental effort perceived for the first and second video. There were no significant differences between conditions for both total mental effort of sleep and APA: ME Sleep total (H (3) = 0.47, p = 0.93), ME APA total (H (3) = 3.75, p = 0.29).

Table 7

Mean total mental effort experienced and standard deviation per condition and video type.

	Video 1: Sleep		Video 2: APA	
	Total ME		Total ME	
Condition	M	SD	M	SD
CC *(n=20; 17)*	5.33	1.86	4.51	2.16
LC *(n=20; 19)*	5.18	1.15	4.82	1.84
SNC *(n=20)*	4.88	1.29	4.59	1.80
SLC *(n= 15)*	5.10	1.22	5.69	1.41
Total (n=75; 71)	*5.12*	*1.40*	*4.84*	*1.85*

Learning (gain scores). Table 8 presents the data of the gain scores for both sleep and APA. Table 9 presents the data of the pre-test and post-test for both sleep and APA. There were no significant differences between conditions for the gain scores for both sleep H (3) = 3.88, p = 0.28 and APA H (3) = 6.17, p = 0.10. Mann-Whitney U-test indicated a non-significant differences for all pair comparisons of sleep; (1) CC and LC (U = 123, z = -1.01, p = 0.31), (2) CC and SNC (U = 148, z = -0.17, p = 0.87), (3) CC and SLC (U = 135, z = -1.07, p = 0.29), (4) LC and SNC (U = 124, z = -1.22, p = 0.22), (5) LC and SLC (U = 122, z = -1.70, p = 0.09) and (6) SNC and SLC (U = 144, z = -1.07, p = 0.29). On the other hand there was a significant difference between SNC and SLC for APA gain score, U = 114, z = -2.33, p = 0.02, for all other pair comparisons there were no significant differences; (1) LC and SLC (U = 199, z = -0.03, p = 0.99), (2) LC and SNC (U = 143, z = -1.54, p = 0.12), (3) CC and SLC (U = 146, z = -1.48, p = 0.13), (4) CC and SNC (U = 155, z = -1.22, p = 0.22), and (5) CC and LC (U = 163, z = -1.02, p = 0.31).

Table 8

Mean sleep and APA gain scores in percentages (standard deviation) per condition.

	Gain Scores Sleep		Gain Scores APA	
Condition	M	SD	M	SD
CC *(n=20)*	-8.71%	14.00	0.78%	35.11
LC *(n=20)*	-3.92%	13.73	9.65%	35.22
SNC *(n=20)*	-11.61%	16.51	-8.36%	34.68
SLC *(n=20)*	-27.79%	37.08	10.80%	29.14
Total (n=80)	*-13.47%*	*24.52*	*2.98%*	*33.29*

Table 9

Mean sleep and APA post-test scores in percentages (standard deviation) per condition.

	Sleep				APA			
	Pre-test		Post-test		Pre-test		Post-test	
Condition	M	SD	M	SD	M	SD	M	SD
CC *(n=20)*	80.88%	12.06	72.17%	10.67	24.43%	19.66	25.21%	32.06
LC *(n=20)*	75.93%	16.88	72.01%	10.45	37.18%	23.34	46.83%	30.33
SNC *(n=20)*	81.48%	9.72	69.87%	11.96	33.76%	19.05	25.40%	30.62
SLC *(n=20)*	76.25%	13.59	48.46%	35.04	18.85%	22.94	29.64%	34.39
Total (n=80)	*77.53%*	*13.43*	*65.33%*	*22.66*	*27.02%*	*22.10*	*30.00%*	*32.43*

Post-test retention and transfer. Table 10 presents the post-test APA scores for retention and transfer per condition. For post-test scores of APA there is no significant difference between conditions, for both retention, H (3) = 7.24, p = 0.07 and transfer, H (3) = 3.29, p = 0.35. When comparing CC and LC there is a significant difference between post-test APA retention scores, U = 114, z = -2.40, p = 0.02, but not for transfer scores.

Repeated measures indicated that the median post-test retention score of APA, *Mdn* = 2, were statistically significantly higher than the median post-test transfer score of APA, *Mdn* = 0, z = -5.92, $p < 0.001$. Comparisons per conditions indicate that the median post-test score retention were significantly higher than the median post-test scores transfer in all conditions, CC (z = -2.67, p = 0.008), LC (z = -3.53, $p < 0.001$), SNC (z = -2.81, p = 0.005) and SLC (z = -2.94, p = 0.003).

Table 10

Mean APA retention and transfer post-test scores (standard deviation and median) per condition.

	Post-test APA Retention			Post-test APA Transfer		
Condition	M	SD	Median	M	SD	Median
CC *(n=20)*	2.50	3.52	0.00	0.50	0.83	0.00
LC *(n=20)*	5.40	3.56	6.00	1.00	1.03	1.00
SNC *(n=20)*	2.65	3.13	0.50	0.60	0.94	0.00
SLC *(n=20)*	3.60	4.10	1.00	0.55	0.89	0.00
Total (n=80)	*3.54*	*3.75*	*2.00*	*0.66*	*0.93*	*0.00*

Note. A maximum of 12 points could be obtained for retention and 2 points for transfer.

Correlations of Sleep and APA. Table 11 presents the Spearman's rho correlation coefficient between coverage, replay, pauses, mental effort and gain scores of sleep. A significant positive correlation was observed between coverage and pauses (r_s = 0.30, N = 80, p = 0.007), gain scores and coverage (r_s = 0.35, N = 74, p = 0.002) and gain scores and pauses (r_s = 0.32, N = 74, p = 0.006). Table 12 presents the Spearman's rho correlation coefficient between coverage, replay, pauses, mental effort, gain scores and post-test scores of APA. A significant positive correlation was observed between replays and coverage (r_s = 0.28, N = 80, p = 0.01), replays and pauses (r_s = 0.37, N = 80, p = 0.001), gain scores and mental effort (r_s = 0.43, N = 70, p = 0.000).

Table 11

Engagement, mental effort of the first video and post-test scores of sleep correlations: Spearman's rho.

	1	2	3	4	5
Variables	r_s	r_s	r_s	r_s	r_s
1. Coverage	-				
2. Pauses	0.301**	-			
3. Replay	-	-	-		
4. Mental effort	0.096	0.078	-	-	
5. Gain score	0.349**	0.317**	-	-0.058	-

*Note. *p < 0.05 **p <0.01*

Table 12

Engagement, mental effort of the second video and post-test scores of APA correlations: Spearman's rho.

	1	2	3	4	5
Variables	r_s	r_s	r_s	r_s	r_s
1. Coverage	-				
2. Pauses	0.198	-			
3. Replay	0.275*	0.365**	-		
4. Mental effort	0.210	-0.036	-0.159	-	
5. Gain score	0.043	0.158	-0.222	0.426**	-

*Note. *p < 0.05 **p <0.01*

Discussion

In line with the first hypothesis, no significant differences were found for engagement between conditions. For the unique play time for both the sleep and APA video, there were no significant differences between conditions. It is notable that participants in SNC viewed both the sleep video and the APA with the highest percentage 90.7% for sleep and 77.7% for APA. Since, participants were not allowed to use learner-control features in this condition their engagement purely rely on their unique play time. Participants in CC were the second highest percentage to view both the sleep and APA video, with a percentage of 78.2% for sleep and 74% for APA. The finding compares favorably with the average of 52% reported by Kim et al. (2014) for videos in MOOCS. Participants in SLC had the lowest percentage of video coverage with 64.2% for sleep and 50,9% for APA, which indicates that this might have had an effect on their use of control features and learning outcome. This low coverage result might be due to participants having the freedom to do the experiment fully online when and where it suited them.

In both LC and SLC no one replayed a section of the video on sleep, this can be explained by the length of the video being close to 25 minutes. Participants might have opted to watch the video in one go to finish faster. This is also in agreement with previous research which have observed that just because control features are available, does not guarantee that learners will use them (Hasler, Kersten & Sweller, 2007). The APA video has been replayed in the LC condition with an average of 10 seconds and SLC of 3 seconds. Since the replay control feature has only been used for the procedural video, this is also in agreement with previous research, that control features are mainly used when the task to be performed is difficult (Schwan & Riemp, 2004). Participants had to mainly remember a lot of facts about the science of sleep for the first video, but for the video on APA, participants had to pay more attention to remember the procedure on how to complete the tasks. For the data collected on replays on the APA video, no significant differences were assessed between conditions. This is in line with the expectation that there are no significant differences between conditions for engagement.

There were no significant differences for number of pauses taken between conditions for both the video on sleep and APA. This is in agreement with the recent study by Biard, Cojean & Jamet (2018) which also compared similar groups to LC and SLC and observed no significant differences between the number of pauses. It is also notable that the average amount of pauses taken for the video of sleep was one and for APA a half. This is also in

agreement with previous research which have observed that just because control features are available, it is not guaranteed that learners will use them (Hasler, Kersten & Sweller, 2007). This is also in line with the expectation that there are no significant differences between conditions for engagement.

Contrary to the second hypothesis, the mental effort measures per segment and the overall mental effort experienced per video showed no significant differences between conditions. By observing the mean of mental effort for both the video on sleep and the video on APA, the values lay between 4 and 6, which indicates that most of the participants indicated that they experienced 'a rather low mental effort', 'neither low nor high mental effort' or 'rather high mental effort'. This might be the case since the participants were asked to fill in the mental-effort questionnaire at the end of video-watching, instead of after each segment. Participants had to think back and make a rough estimation on how much mental effort they thought they perceived after each segment. This resulted in the participants choosing the values in the middle of the range from 1 to 9. This caused the results to deviate from previous research observing that learner-control resulted in less mental effort while learning, compared to segmented system-control (Stiller & Zinnbauer, 2011), while segmented system-control yields less mental effort compared to continuous system-control (Spanjers, van Gog, Wouters, & van Merriënboer, 2012; Spanjers, Wouters, van Gog, & van Merriënboer, 2011).

Opposed to the third hypothesis, only when comparing the segmented system-control conditions, SNC and SLC, significant differences between gain scores for APA were found. Participants in SNC had a negative gain, while participants in CC, LC and SLC all had a positive gain. Indicating that for procedural learning, a segmented interactive video performs better than a segmented non-interactive video. SLC had the most positive gain and LC the second most positive gain with a 1% difference. These results are in line with previous research resulting many times in learner-control yielding higher scores compared to both continuous and segmented system-control, for procedural learning (Betrancourt, 2005; Hasler, Kersten & Sweller, 2007; Stiller & Zinnbauer, 2011; Tabbers, 2002). These results are also in line with the recent study by Biard, Cojean & Jamet (2018) which observed that segmented interactive video for procedural learning resulted in higher scores when compared to an interactive video. Furthermore, this study also observed that a segmented interactive video performs better than a segmented non-interactive video.

On the other hand, there was a negative gain for sleep in all conditions, with LC having the least negative gain, CC second to least negative gain and SLC with the most negative, double the amount of the total mean. It can be observed that for conceptual learning participants in SLC performed the worst, even though for procedural learning participants in SLC were the best performers. This indicates that a segmented interactive video can be beneficial for procedural learning but might be less beneficial for conceptual learning.

Additionally, studies have resulted in segmented system-control being superior to continuous system-control yielding higher scores for learning (Mayer & Chandler, 2001; Boucheix & Guignard, 2005; Moreno, 2007; Spanjers, van Gog & Van Merriënboer, 2010; Spanjers, van Gog, Wouters, & van Merriënboer, 2012). In this study no significant differences between SNC and CC were found. This might have been due to not having a big enough distinction in video design between the video used for SNC and CC, since for the conceptual topic of sleep, both videos consisted of labels. For the procedural topic of APA, the distinction between video design could have also been bigger, by implementing more video-design guidelines in the video used for SNC, since only pauses were added in the video.

Furthermore, there was a significant difference between CC and LC for post-test retention APA scores, CC having a mean of 2.5 and LC 5.4. This indicates that learner-control aids retention better than continuous system-control for procedural learning. These results are in line with previous research resulting in learner-control yielding higher scores compared to system-control, for procedural retention (Betrancourt, 2005; Hasler, Kersten & Sweller, 2007; Stiller & Zinnbauer, 2011; Tabbers, 2002).

Multiple significant positive correlations were observed, mainly between the engagement variables, indicating that the more you viewed a video, the more likely a participant was to use the control features. For the video of sleep there were also some notable correlations between the gain score, mainly between coverage and pauses, which indicates the longer the unique play time of a participant, the higher the gain score. Also, the more pauses a participant took, the higher the gain score. For the video of APA, a positive correlation was observed between mental effort and gain scores. This result indicates that for procedural learning the higher the mental effort, the higher the gain score. This is opposed to previous research, stating that a video which generates a very high cognitive load will result in a low learning outcome (Sweller, van Merrienboer, & Paas, 1998). This opposing result might have been due to the mental-effort questionnaire not being properly implemented in the

experiment procedure, participants should have been asked to rate their mental effort after each segment, instead of at the end of video-watching. This implementation would have resulted in more precise mental effort measures.

Conclusion

There are clearly a few limitations experienced in this research. Firstly, participants were able to participate in the experiment fully online, when and where it suited them best, having no time restrictions and full control on viewing of the videos. It is not clear whether participants were potentially distracted while viewing the videos. Secondly, the videos used for the experiments could have consisted of a bigger difference between the continuous and segmented videos, only a few pacing-manipulations were implemented in the video, such as the use of labels, pauses and dimmed black screen during a pause. Other pacing-elements could have been used such as an index table. Lastly, the assessment of mental-effort could have been implemented differently, having participants rate their mental-effort after each segment and not until the end of video watching.

For future research, the use of learner control features has to be studied more in depth, which has been indicated by a handful of studies e.g., Hasler, Kersten & Sweller, 2007; Schwan & Riempp, 2004; Tabbers & Koeijer, 2009. The present study observed the number of pauses taken and the replay time, future research is necessary in studying the duration of pauses, the time when the pauses are taken and also studying the effects of other types of learner-control features, such as fast-forwarding. Secondly, more information can be gained on the effects of learner-control and system-control videos on long-term retention and transfer by inviting participants to take a delayed post-test, a few weeks after the experiment. Lastly, for procedural knowledge development it can be useful to study the effects of combining learner-control and system-control with in-video practice. Several studies have shown that practice can be beneficial for learning (e.g., van der Meij & Dunkel, 2020; Hodges & Coppola, 2015; van Gog, 2011).

The findings of the present study give a promising prospect for the effectiveness of segmentation with learner-control for procedural video-based learning. There was a substantial engagement with both educational videos. Furthermore, segmentation with learner-control resulted in obtaining the highest gain scores for procedural learning, but the

opposing effect for conceptual learning. As such, this study extends a growing set of studies that support the effectiveness of segmented learner-control for procedural video-based learning e.g., Biard, Cojean & Jamet, 2018; Cojean & Jamet, 2017, 2018. Yet, more research is needed to further analyse the effects of segmented interactive video for conceptual video-based learning. This study has contributed to the understanding of how effective system-control and learner-control are for video-based learning. Foremost, the present study supports the use of segmented learner-control over the use of a system- and learner-controlled video for procedural learning.

References

Barr, C., Doyle, M., Clifford, J., De Leo, T., Dubeau, C. (2003). There is More to Math: A Framework for Learning and Math Instruction. *Waterloo Catholic District School Board.*

Betrancourt, M. (2005). The Animation and Interactivity Principles in Multimedia Learning. *The Cambridge Handbook of Multimedia Learning*, 287-296. doi:10.1017/cbo9780511816819.019

Biard, N., Cojean, S., & Jamet, E. (2018). Effects of segmentation and pacing on procedural learning by video. *Computers in Human Behavior*, 89, 411-417. doi:10.1016/j.chb.2017.12.002

Brar, J., & Meij, H. V. (2017). Complex software training: Harnessing and optimising video instruction. *Computers in Human Behavior*,70, 475-485. doi:10.1016/j.chb.2017.01.014

Cojean, S., & Jamet, E. (2017). Facilitating information-seeking activity in instructional videos: The combined effects of micro- and macroscaffolding. *Computers in Human Behavior*, *74*, 294–302. doi: 10.1016/j.chb.2017.04.052

Cojean, S., & Jamet, E. (2018). The role of scaffolding in improving information seeking in videos. Journal of Computer Assisted Learning, 34(6), 960–969. doi: 10.1111/jcal.12303

Giannakos, M. N. (2013). Exploring the video-based learning research: A review of the literature: Colloquium. *British Journal of Educational Technology*, 44(6), E191eE195. doi:10.1111/bjet.12070.

Gold, D. A., Zacks, J. M., & Flores, S. (2017). Effects of cues to event segmentation on subsequent memory. *Cognitive Research: Principles and Implications*, 2(1). doi:10.1186/s41235-016-0043-2

Hasler, B. S., Kersten, B., & Sweller, J. (2007). Learner control, cognitive load and instructional animation. *Applied Cognitive Psychology,21*(6), 713-729. doi:10.1002/acp.1345

Hegarty, M. (2014). Multimedia Learning and the Development of Mental Models. *The Cambridge Handbook of Multimedia Learning,*673-702. doi:10.1017/cbo9781139547369.033

Hiebert, J., & Lefevre, P. (1986). Conceptual and procedural knowledge in mathematics: An introductory analysis. In J. Hiebert (Ed.), *Conceptual and procedural knowledge: The case of mathematics* (pp. 1-27). Hillsdale, NJ, US: Lawrence Erlbaum Associates, Inc.

Höffler, T. N., & Leutner, D. (2007). Instructional animation versus static pictures: A meta-Analysis. *Learning and Instruction, 17*(6), 722-738. doi:10.1016/j.learninstruc.2007.09.013

Höffler, T. N., & Schwartz, R. N. (2011). Effects of pacing and cognitive style across dynamic and non-dynamic representations. *Computers & Education,57*(2), 1716-1726. doi:10.1016/j.compedu.2011.03.012

Hodges, N. J., & Coppola, T. (2015). What we think we learn from watching others: The moderating role of ability on perceptions of learning from observation. Psychological Research, 79, 609–620. doi:10.1007/s00426-014-0588-y

Kim, J., Guo, P. J., Seaton, D. T., Mitros, P., Gajos, K. Z., & Miller, R. C. (2014). Understanding in-video dropouts and interaction peaks inonline lecture videos. Proceedings of the First ACM Conference on Learning @ Scale Conference - L@S 14. doi: 10.1145/2556325.2566237

Kurby, C. A., & Zacks, J. M. (2008). Segmentation in the perception and memory of events. *Trends in Cognitive Sciences*, 12(2), 72-79. doi:10.1016/j.tics.2007.11.004

Matthews, K. (2018, June 06). Online Video is Everywhere and Filling Up Data Centres. Retrieved from https://datacenterfrontier.com/online-video-is-everywhere-and-filling-up-data-centers/

Mayer, R. E. (1999). Designing instruction for constructivist learning. In C. M. Reigeluth (Ed.), Instructional design theories and models: A new paradigm of instructional theory (pp. 141-159). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Mayer, R. E. (2005). Cognitive Theory of Multimedia Learning. *The Cambridge Handbook of Multimedia Learning*,31-48. doi:10.1017/cbo9780511816819.004

Mayer, R. (2nd Ed.). (2014). *The Cambridge Handbook of Multimedia Learning* (Cambridge Handbooks in Psychology). Cambridge: Cambridge University Press. doi:10.1017/CBO9781139547369

Merriënboer, J. J., & Kester, L. (2005). The Four-Component Instructional Design Model: Multimedia Principles in Environments for Complex Learning. *The Cambridge Handbook of Multimedia Learning*,71-94. doi:10.1017/cbo9780511816819.006

Muijs, D. (2004). Doing quantitative research in education with SPSS. London: SAGE Publications, Ltd doi: 10.4135/9781849209014

Next-Lab. (2018). Next Generation Stakeholders and Next Level Ecosystem for Collaborative Science Education with Online Labs. Retrieved from www. graasp.eu

Paas, F. G., Merriënboer, J. J., & Adam, J. J. (1994). Measurement of Cognitive Load in Instructional Research. *Perceptual and Motor Skills,79*(1), 419-430. doi:10.2466/pms.1994.79.1.419

Plaisant, C., & Shneiderman, B. (2005). Show Me! Guidelines for Producing Recorded Demonstrations. *2005 IEEE Symposium on Visual Languages and Human-Centric Computing (VL/HCC05)*. doi:10.1109/vlhcc.2005.57

Rittle-Johnson, B., & Alibali, M. W. (1999). Conceptual and procedural knowledge of mathematics: Does one lead to the other? *Journal of Educational Psychology,91*(1), 175-189. doi:10.1037/0022-0663.91.1.175

Scheiter, K. (2014). The Learner Control Principle in Multimedia Learning. In R. Mayer (Ed.), *The Cambridge Handbook of Multimedia Learning* (Cambridge Handbooks in Psychology, pp. 487-512). Cambridge: Cambridge University Press. doi:10.1017/CBO9781139547369.025

Schwan, S., & Riempp, R. (2004). The cognitive benefits of interactive videos: Learning to tie nautical knots. *Learning and Instruction,14*(3), 293-305. doi:10.1016/j.learninstruc.2004.06.005

Spanjers, I. A., Gog, T. V., & Merriënboer, J. J. (2010). A Theoretical Analysis of How Segmentation of Dynamic Visualizations Optimizes Students Learning. *Educational Psychology Review,*22(4), 411-423. doi:10.1007/s10648-010-9135-6

Spanjers, I. A., Gog, T., & Merriënboer, J. J. (2011). Segmentation of Worked Examples: Effects on Cognitive Load and Learning. *Applied Cognitive Psychology*,26(3), 352-358. doi:10.1002/acp.1832

Spanjers, I. A., Gog, T. V., Wouters, P., & Merriënboer, J. J. (2012). Explaining the segmentation effect in learning from animations: The role of pausing and temporal cueing. *Computers & Education,59*(2), 274-280. doi:10.1016/j.compedu.2011.12.024

Spanjers, I. A., Wouters, P., Gog, T. V., & Merriënboer, J. J. (2010). An expertise reversal effect of segmentation in learning from animated worked-out examples. *Computers in Human Behavior,*27(1), 46-52. doi: 10.1016/j.chb.2010.05.011

Stiller, K. & Zinnbauer, P. (2011). Does Segmentation of Complex Instructional Videos in

Big Steps Foster Learning? The Segmentation Principle Applied to a Classroom Video. In S. Barton, J. Hedberg & K. Suzuki (Eds.), *Proceedings of Global Learn Asia Pacific 2011--Global Conference on Learning and Technology* (pp. 2044-2053). Melbourne, Australia: Association for the Advancement of Computing in Education (AACE). Retrieved November 7, 2018, from https://www.learntechlib.org/primary/p/37442/.

Tabbers, H. (2002). The modality of text in multimedia instructions: Refining the design guidelines. Unpublished doctoral dissertation. The Open University of the Netherlands, The Netherlands.

Tabbers, H. K., & Koeijer, B. D. (2009). Learner control in animated multimedia instructions. *Instructional Science,38*(5), 441-453. doi:10.1007/s11251-009-9119-4

van der Meij, H., & Carroll, J. M. (1996). Ten misconceptions about minimalism. *IEEE transactions on professional communication*, *39*(2), 72-86.

van der Meij, H., & Dunkel, P. (2020). Effects of a review video and practice in video-based statistics training. Computers and Education, 143, [103665]. doi:10.1016/j.compedu.2019.103665

van der Meij, H., & van der Meij, J. (2013). Eight guidelines for the design of instructional videos for software training. *Technical Communication*, 60(3), 205-228.

Wouters, P., Tabbers, H. K., & Paas, F. (2007). Interactivity in Video-based Models. *Educational Psychology Review,19*(3), 327-342. doi:10.1007/s10648-007-904

Zacks, J. M. (2010). How We Organize Our Experience into Events. *PsycEXTRA Dataset.* doi:10.1037/e554772011-002

Appendices

Appendix A

Mental Effort Questionnaire – The Science of Sleep

Please indicate below the amount of mental effort you perceived per segment

At section 1 0:00 – 3:54, I invested:

- Very, very low mental effort
- Very low mental effort
- Low mental effort
- Rather low mental effort
- Neither low nor high mental effort (average)
- Rather high mental effort
- High mental effort
- Very high mental effort
- Very, very high mental effort

At section 2 3:55 – 7:07, I invested:

- Very, very low mental effort
- Very low mental effort
- Low mental effort
- Rather low mental effort
- Neither low nor high mental effort (average)
- Rather high mental effort
- High mental effort
- Very high mental effort
- Very, very high mental effort

At section 3 7:08 – 11:58, I invested:

- Very, very low mental effort
- Very low mental effort
- Low mental effort
- Rather low mental effort
- Neither low nor high mental effort (average)

- Rather high mental effort
- High mental effort
- Very high mental effort
- Very, very high mental effort

At section 4 11:59 – 15:30, I invested:

- Very, very low mental effort
- Very low mental effort
- Low mental effort
- Rather low mental effort
- Neither low nor high mental effort (average)
- Rather high mental effort
- High mental effort
- Very high mental effort
- Very, very high mental effort

At section 5 15:31 – 22:55, I invested:

- Very, very low mental effort
- Very low mental effort
- Low mental effort
- Rather low mental effort
- Neither low nor high mental effort (average)
- Rather high mental effort
- High mental effort
- Very high mental effort
- Very, very high mental effort

At section 6 22:56 – 25:22, I invested:

- Very, very low mental effort
- Very low mental effort
- Low mental effort
- Rather low mental effort
- Neither low nor high mental effort (average)
- Rather high mental effort

- High mental effort
- Very high mental effort
- Very, very high mental effort

Mental Effort Questionnaire – APA

Please indicate below the amount of mental effort you perceived per segment

At section 1 0:00 - 2:39, I invested:

- Very, very low mental effort
- Very low mental effort
- Low mental effort
- Rather low mental effort
- Neither low nor high mental effort (average)
- Rather high mental effort
- High mental effort
- Very high mental effort
- Very, very high mental effort

At section 2 2:40 - 4:57, I invested:

- Very, very low mental effort
- Very low mental effort
- Low mental effort
- Rather low mental effort
- Neither low nor high mental effort (average)
- Rather high mental effort
- High mental effort
- Very high mental effort
- Very, very high mental effort

At section 3 4:58 - 6:05, I invested:

- Very, very low mental effort
- Very low mental effort
- Low mental effort
- Rather low mental effort
- Neither low nor high mental effort (average)
- Rather high mental effort
- High mental effort
- Very high mental effort

- Very, very high mental effort

At section 4 6:06 - 7:52, I invested:

- Very, very low mental effort
- Very low mental effort
- Low mental effort
- Rather low mental effort
- Neither low nor high mental effort (average)
- Rather high mental effort
- High mental effort
- Very high mental effort
- Very, very high mental effort

Appendix B

Prior Knowledge Test – The Science of Sleep

1. We tend to wake up and go to sleep around the same time every day.
   What is responsible for this process? *(2 points)*

2. During which part of a 24-hour day do we tend to be at our cognitive best? *(1 point)*

3. During which parts of a 24-hour day is our desire to sleep the highest? *(1 point)*

4. Why do we need sleep?
   Give three reasons why people need sleep. *(3 points)*

5. What happens when we do not get enough sleep?
   Give three negative consequences of what will happen if people do not get enough sleep. *(3 points)*

6. What are two things you should **not** do before deciding to go to sleep which will not allow you to fall asleep? *(2 points)*

Appendix C

Prior Knowledge Test – APA

1. Formatting and writing styles have to be followed when writing scientific articles. A well-known formatting style is the APA-style.
   Why do we need to follow such writing styles? *(2 points)*

2. What are the main formatting requirements on the title page when following the APA-style? Mention five elements. *(5 points)*

Table 1

Summary of Studies Included in Meta-Analysis on the Effectiveness of Rocking Out Like No One's Watching (ROLNOW)

Study	N	Cohen's d	SD
Atashin (2013)	384	0.86	0.63
Dumile & Jackson (2015)	176	1.21	0.95
Garcia, Homme, Oliveri & Bjork (2014)	231	0.72	0.64

Iyer, Lehman, Sorey (2014)	406	1.14	0.97
Onuki, Agata & Hamamoto (2014)	127	0.63	0.41

3. Which **parts** of Table 1 are **not** formatted using the APA-style?
   Mention the parts and give the reason why they are not formatted using the APA-style. *(4 points)*

Figure 1. A path model of alcohol consumer behavior.

4. Which parts of Figure 1 are **not** formatted using the APA-Style?
   Mention the parts and give the reason why they are not formatted using the APA-style. *(2 points)*

Appendix D

Coding Scheme Prior Knowledge Tests

Sleep.

BS1. We tend to wake up and go to sleep around the same time every day. What is responsible for this process? (2 points)

A11. A natural/biological clock/cycle which is influenced by light(melatonin)	(2 points)
A11. A natural/biological clock/cycle; day & night cycle	(1 point)
A11. (our) brain; biology/science	(0 points)
A12. Our circadian rhythm	(2 points)
A12. (Sleeping) rhythm; (sleeping) habit; (sleeping) routine; (sleeping) pattern	(1 point)
A12. Regular life	(0 points)
A13. Light(melatonin)	(1 point)

BS2. During which part of a 24-hour day do we tend to be at our cognitive best? (1 point)

A21. (late) morning (9:00-11:59)	(1 point)
A21. During mid-day; around noon	(0 points)
A22. A few hours after waking up; before lunch	(1 point)
A22. Awake; night; while sleeping	(0 points)

BS3. During which part of a 24-hour day is our desire to sleep the highest? (1 point)

A31. Late night; in the night; evening (2am-4am)	(1 point)
A31. At the start of the evening	(0 point)
A32. Afternoon (2pm-3pm)	(1 point)
A32. After eating; after food or drinks; late afternoon	(0 point)

BS4. Why do we need sleep? Give three reasons why people need sleep. (3 points)

A41. To attract less attention (mostly applicable for animals)	(1 point)
A42. Conserve energy; regain energy; recharge; better for immune system	(1 point)
A42. Moody	(0 points)
A43. Restauration; rest; heal; restore; cleansing; recover; repair; reset (clear) the body and mind	(1 point)
A44. Brain plasticity; brain processes; concentration/memory improves, thinking	(1 point)

A45. Physical functioning improves; better athletic performance; better organ functioning (1 point)

A46. Regenerate; Cells regeneration; renewing of cells (1 point)

A46. To grow (0 points)

A47. Relieve stress; relax (1 point)

BS5. What happens when we do not get enough sleep? Give three negative consequences of what will happen if people do not get enough sleep. (3 points)

A51. Sleep deprivation; fatigue; depression; tired; exhausted (1 point)

A51. Can't grow (0 points)

A52. Emotional jell-O; moody; stress; anxiety; cranky;depression; what-the-hell effect (1 point)

A52. Less motivated (0 points)

A53. Lack/Negative effects on memory and speech control; (1 point)
trouble focusing; slower reaction time; less concentration

A53. Headache (0 points)

A54. Paranoia; Hallucinations; irrational acting; psychological problems (1 point)

A55. Low immune health; more prone to eat unhealthy food; (1 point)
weight gain; feeling easily sick; more susceptible to diseases

A55. Hormonal problems (0 points)

BS6. What are two things you should not do before deciding to go to sleep which will not allow you to fall asleep? (2 points)

A61. (blue) Light; phone or laptops in bed; (1 point)

A61. Listen to music, laughter (0 points)

A62. Caffeine consumption; taking stimulant drugs; energy drinks (1 point)

A63. Worrying; Stressing; too much learning ; thinking (1 point)

A64. After eating a heavy meal; eat or drink (a lot) (1 point)

A65. After exercising (1 point)

Total 12 points

APA.

BA1. Formatting and writing styles have to be followed when writing scientific articles. A well-known formatting style is the APA-style. Why do we need to follow such writing styles? (2 points)

A11. They are rules and guidelines; it is like a universal language; following standards; Standardize (1 point)

A11. To have an overview (0 points)

A12. They ensure clarity; easy to understand (1 point)

A13. They ensure a consistent presentation; coherency; organized; structured (1 point)

A14. They increase the ease of reading comprehension; more readable, avoids confusion (1 point)

A15. Easier to retrieve the references; for publishing in journals; indexing references (1 point)

A15. To avoid plagiarism (0 points)

BA2. What are the main formatting requirements on the title page when following the APA-style? Mention five elements. (5 points)

A21. The title is centered on the page (1 point)

A21. APA is only for referencing (0 points)

A22. The title is no longer than 12 words (1 point)

A23. Do not use title for authors names (1 point)

A24. Running head (on top which does not exceed 50 characters) (1 point)

A25. Double spaced typing (1 point)

A26. It has to consist of a title (1 point)

A27. It has to consist of authors name (1 point)

A28. It has to consist of the Institution/affiliation name (1 point)

A29. Font type Times new roman (1 point)

A210.font size 11,12 (1 point)

A211. Set margins (1 point)

BA3. Which parts of Table 1 are not formatted using the APA-style? Mention the parts and give the reason why they are not formatted using the APA-style. (4 points)

A31. ‘Table 1’ should not be bold. (1 point)

A32. Title of the table should be in italics (1 point)

A33. Statistical names (N, d, SD) should be in italics (1 point)

A34. The table should only have (3) horizontal borderlines (1 point)

A35. Citation in the table is not apa or not proper (1 point)

A36. Source (note) is not mentioned in the table (1 point)

BA4. Which parts of Figure 1 are not formatted using the APA-Style? Mention the parts and give the reason why they are not formatted using the APA-style. (2 points)

A41. Figure caption should be under the figure (1 point)

A42. 'Figure 1' should be in italics (1 point)

A43. Text within the figure is not properly capitalized, information in the path model could be indicated differently (consist of measurable constructs) or arrows are misplaced(1 point)

A44. Source is not mentioned in the figure (1 point)

Total: 13 points

Appendix E

Post Knowledge Test- The Science of Sleep

1. Describe what the Circadian Rhythm is. *(1 point)*

_____

2. Which three daily necessities are affected by the Circadian Rhythm? *(3 points)*

_____

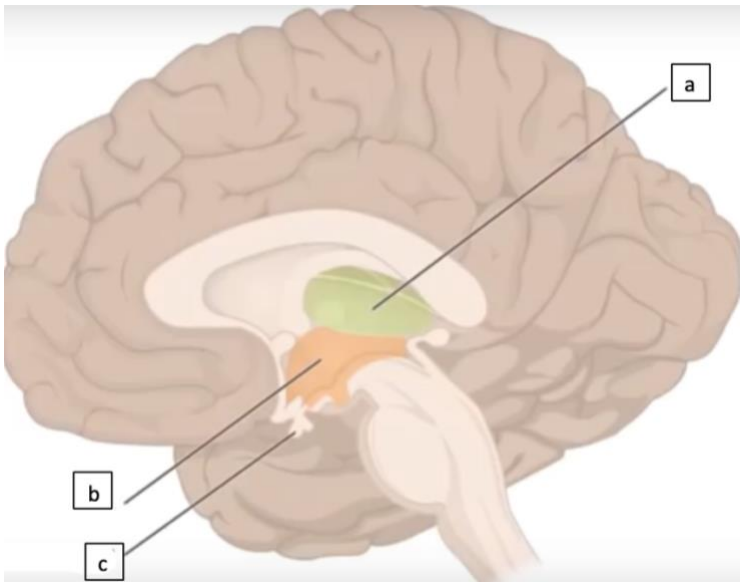
_____

_____

3. What is the main regulator of the Circadian Rhythm? *(1 point)*

---

4. Where in the brain is the main regulator of the Circadian Rhythm located? *(1 point)*



a.

b.

c.

5. Which group of nerve cells are connected to our optic nerves that send signals to raise our temperature, heart rate, blood pressure, and delay the release of hormones like melatonin when light is sensed? *(1 point)*

_____

6. During which part of a 24-hour day do we tend to be at our cognitive best? *(1 point)*

_____

7. During which parts of a 24-hour day is our desire to sleep the highest? *(1 point)*

_____

8. Disruptions to our natural rhythms may lead to some health issues, name 3. *(3 points)*

_____

_____

_____

9. What are the names of the so-called ‘awake’ hormones and ‘sleepy’ hormones? *(2 points)*

_____

10. Why do we need sleep?

Give three reasons why people need sleep. *(3 points)*

_____

_____

_____

11. What happens when we do not get enough sleep?
    Give three negative consequences to what will happen if people do not get enough sleep. *(3 points)*

_____

_____

_____

12. What are two things you should **not** do before deciding to go to sleep which will not allow you to fall asleep? *(2 points)*

_____

_____

13. What is sleep paralysis? *(1 point)*

_____

14. What is hyperarousal? *(1 point)*

_____

15. What is sleep-apnea? *(1 point)*

_____

16. Give a reason why some people sleep-walk? *(1 point)*

_____

_____

Appendix F

Post Knowledge Test – APA

Table 1

Summary of Studies Included in Meta-Analysis on the Effectiveness of Rocking Out Like No One's Watching (ROLNOW)

Study	N	Cohen's d	SD
Atashin (2013)	384	0.86	0.63
Dumile & Jackson (2015)	176	1.21	0.95
Garcia, Homme, Oliveri & Bjork (2014)	231	0.72	0.64
Iyer, Lehman, Sorey (2014)	406	1.14	0.97
Onuki, Agata & Hamamoto (2014)	127	0.63	0.41

1. Which **parts** of Table 1 are **not** formatted using the APA-style?
   Mention the parts and give the reason why they are not formatted using the APA-style. *(4 points)*

Figure 1. A path model of alcohol consumer behavior.

2. Which parts of Figure 1 are **not** formatted using the APA-Style?
   Mention the parts and give the reason why they are not formatted using the APA-style. *(2 points)*

You are now going to perform five tasks.

3. You have to format the table below using APA-style and the new gained knowledge from the video. *(4 points)*

Table 1

Dogs Scoring Above Average on Intelligence by Breed and Gender

Breed	Male	Female	%
Dachshund	123	234	17.6
Terrier	456	567	31.1
Siberian Husky	789	891	51.3
Totals (N=3060)	1368	1692	

Note. Average score = 150. No animals were harmed during testing

4. You have to format the figure below using APA-style and the new gained knowledge from the video. *(2 points)*

Figure 1

Dogs Breed Included in This Study

5. You have to reference the table and the figure in the following piece of text using the way it was done in the video. *(1 point)*

Results

This study focused on comparing the intelligence of three different dog breeds. The results can be seen in ….. A visual depiction of the dog breeds that participated in this study can be seen in …..

For the following two tasks you are **not allowed** to type out the items. You have to use a handy function in Word to create the following lists.

6. You have to create a ‘List of Tables’. *(1 point)*

7. You have to create a ‘List of Figures’. *(1 point)*

Appendix G

Coding Scheme Post Tests

Sleep.

AS1. Describe what the Circadian Rhythm is. (1 point)

C21. (24-hour) biological/internal cycle/clock/rhythm (1 point)

C21. Brain cycle (0 points)

C22. Sleep/awake (day-night) cycle, system that regulates when you sleep and wake up/sleeping rhythm (1 point)

AS2. Which three daily necessities are affected by the Circadian Rhythm? (3 points)

C31. Sleeping , nap, resting, energy (1 point)

C31. Waking up, light, focus of brain, loss in sleep, tiredness, memory, thinking, brain function (0 points)

C32. Eating, food for eating, nutrition, hunger, metabolism (1 point)

C32. immune system (0 points)

C33. Mating, mood, hormones (1 point)

C33. cell regeneration (0 points)

AS3. What is the main regulator of the Circadian Rhythm? (1 point)

C41. Hypothalamus (1 point)

C41. Light, thalamus, melatonin or cortisol, pineal gland, time of sleep, SCN, something inside the brain, dopamine (0 points)

AS4. Where in the brain is the main regulator of the Circadian Rhythm located? (1 point)

C51. B. (1 point)

C51. A, C. (0 points)

AS5. Which group of nerve cells are connected to our optic nerves that send signals to raise our temperature, heart rate, blood pressure, and delay the release of hormones like melatonin when light is sensed? (1 point)

C61. The suprachiasmatic nucleus (SCN(-nerves)) (1 point)

C61. synapses, neurons, Gaba, cortisol, amygdala, nerves, pineal gland, melatonin

(0 points)

AS6. During which part of a 24-hour day do we tend to be at our cognitive best?

(1 point)

C71. (late/end) morning (9:00-11:59) (1 point)

C71. During mid-day; day; around noon (0 points)

C72. A few hours after waking up; before lunch (1 point)

C72. Awake; night; while sleeping (0 points)

AS7. During which part of a 24-hour day is our desire to sleep the highest? (1 point)

C81. Late night; in the night; evening (2am-4am) (1 point)

C82. Afternoon (2pm-3pm) (1 point)

C82. After eating; after food or drinks (0 point)

AS8. Disruptions to our natural rhythms may lead to some health issues, name 3.

(3 points)

C91. Diabetes (1 point)

C91. Irregular heartbeat (0 points)

C92. Obesity, weight problems, stroke (1 point)

C93. Depression, mood disorders, mental conditions, mental health issues (1 point)

C93. Lower happiness, loneliness (0 points)

C94. Dementia (1 point)

C94. Lack of concentration, feels tired (fatigue); memory problems (0 points)

C95. (cardio)Vascular diseases, heart diseases, heart malfunction, cardiac problems (1 point)

C96. Insomnia (1 point)

AS9. What are the names of the so-called 'awake' hormones and 'sleepy' hormones?

(2 points)

C101. Cortisol (cortizon) (1 point)

C101. adrenaline, testosteron, gaba, denosine, serotonin, adenosine, dopamine, seratonin, depression (0 points)

C102. Melatonin (1 point)

AS10. Why do we need sleep? Give three reasons why people need sleep. (3 points)

C111. To attract less attention (mostly applicable for animals) (1 point)

C112. Conserve energy; regain energy; store energy, preserve energy; regenerate (1 point)

C112. Moody (0 points)

C113. Restauration; rest; heal; restore; cleansing; recuperate; recover (1 point)
recover; reset the body and mind; repair

C114. Brain plasticity; brain processes; concentration/memory improves; store memory; improves thinking processes; better at remembering (1 point)

C115. Physical functioning improves (1 point)

C116. Cells regeneration; renewing of cells; develop muscle; repair tissue (1 point)

C116. To grow (0 points)

C117. Relieve stress; relax (1 point)

AS11. What happens when we do not get enough sleep? Give three negative consequences of what will happen if people do not get enough sleep. (3 points)

C121. Sleep deprivation; fatigue (1 point)

C121. Can't grow (0 points)

C122. Emotional jell-O; moody; stress; anxiety; cranky; depression (1 point)

C122. Less motivated (0 points)

C123. Lack/Negative effects on memory and speech control; (1 point)
trouble focusing; slower reaction time; motorskills decrease, higher rates of accidents(tripping, falling); lack of concetration

C123. Headache (0 points)

C124. Paranoia; Hallucinations (1 point)

C125. Low immune health; more prone to eat unhealthy food; (1 point)
weight gain; feeling easily sick; more prone to diseases

C125. Hormonal problems (0 points)

AS12. What are two things you should not do before deciding to go to sleep which will not allow you to fall asleep? (2 points)

C131. Light; no phone or laptops in bed; (1 point)

C131. Listen to music (0 points)

C132. Caffeine consumption; taking stimulant drugs (1 point)

C133. Worrying; Stressing, thinking (1 point)

C134. After eating a heavy meal (1 point)
C135. After exercising (1 point)

AS13. What is sleep paralysis? (1 point)
C141. A temporary inability to move or speak that occurs when you are waking up or falling asleep, Body is still in REM and can't move, while the mind is awake and aware, not being able to move after waking up, also only mentioning not being able to move when falling asleep or waking up, you are awake while paralyzed. (1 point)
C141. During sleep not being able to move or speak, dreaming while awake, inability to move (0 points)

AS14. What is hyperarousal? (1 point)
C151. Hyperarousal is when the nervous system remains in a constant state of alert. Super alert and aware, being in a constant fight or flight mode, brain is too awake to fall asleep. (1 point)
C151. States who gets hyper aroused instead of explaining what it is for example people with post-traumatic stress disorder may experience hyperarousal, very anxious. Awake at unusual times. (0 points)

AS15. What is sleep-apnea? (1 point)
C161. When your breathing is interrupted while you are sleeping (1 point)
C161. Describes symptoms of sleep apnea Snoring (0 point)

AS16. Give a reason why some people sleep-walk? (1 point)
C171. Some scientists think it is caused by the brain trying to circumvent other stages of sleep and go directly from deep non-REM sleep to full-on wakefulness. (1 point)
C171. Hyperarousal, the brain is overly active (0 points)
C172. Others point to a chemical messenger in our body known as GABA which normally serves to slow down activity in the brains motor system. (1 point)
C173. Children lack the fully developed neurons that release GABA. (1 point)
C173. Age (without specifying that children may sleepwalk more than adults) (0 points)
C174. Sleep deprivation. (1 point)
C175. Stress, disturbed psychology, anxiety (1 point)
C176. Drug use. (1 point)

C177. Some people are genetically predisposed to sleep-walking. (1 point)

C178. (deficiency) Chromosome 20 in DNA (1 point)

Total: 26 points

APA.

AA1. Which parts of Table 1 are not formatted using the APA-style? (4 points)

Mention the parts and give the reason why they are not formatted using the APA-style.

C191. 'Table 1' should not be bold. (1 point)

C192. Title of the table should be in italics (1 point)

C193. Statistical names (N, d, SD) should be in italics (1 point)

C194. The table should only have (3) horizontal borderlines (1 point)

C195. Citation in the table is not apa (1 point)

C195. Some citations in the table are incorrectly formulated (0 points)

C196. Source (note) is not mentioned in the table (1 point)

C197. Single spaced (1 point)

AA2. Which parts of Figure 1 are not formatted using the APA-Style? (2 points)

Mention the parts and give the reason why they are not formatted using the APA-style.

C201. Figure caption should be under the figure (1 point)

C202. 'Figure 1' should be in italics (1 point)

C203. Text within the figure is not properly capitalized (1 point)

C204. Source is not mentioned in the figure (1 point)

AA3. You have to format the table below using APA-style and the new gained knowledge from the video. (3 points)

C211. Table 1 should not be bold. (1 point)

C212. Name/title of the table should be in italics. (1 point)

C213. Statistical names should be in italics. (1 point)

C214. Table should only consist of horizontal lines. (1 point)

C215. Use of proper table captioning by using the Word-function. (1 point)

C216. Title should be placed above the table. (1 point)

AA4. You have to format the figure below using APA-style and the new gained knowledge from the video. (2 points)

C221. Figure title should be below the figure. (1 point)

C222. The title 'Figure 1' should be in italics. (1 point)

C223. Use of proper figure captioning by using the Word-function. (1 point)

AA5. You have to reference the table and the figure in the following piece of text using the way it was done in the video. (1 points)

C231. In-text citation function use. (1 point)

C232. Proper placement of in-text citation. (1 point)

AA6. You have to create a 'List of Tables'. (1 points)

C241. List of Tables function use. (1 point)

C242. Proper lay-out of list of tables. (1 point)

AA7. You have to create a 'List of Figures'. (1 points)

C251. List of Figures function use. (1 point)

C252. Proper lay-out of list of figures. (1 point)

Total: 14 points

Appendix H

Detailed Experiment Script

Researcher Preparation

1. Before the experiment
    - Make sure all participants are informed when, at what time and where they are expected to be present for the experiment.
    - Make sure to allocate all participants randomly to one of the four groups.
    - Make sure enough consent forms are printed (2 copies per participant, one for the research one for the participant).
    - Make sure the experiment script is printed out, so the researcher does not forget to say something.
    - Make sure all the questionnaires are printed out (demographic, prior knowledge, mental effort and gained knowledge) for each participant.
    - Make sure there is a blue pen which the participants can use to fill in the informed consent form.
    - Make sure there is a gray pencil which the participants can use to fill in the questionnaires.
    - Make sure the videos to be watched are opened on two separate windows on the computer.

2. During the experiment
    - Make sure that the participants fill in all the questions
    - Make sure that the participants are comfortable
    - Give clear and consistent instructions

Experiment Session

Time	Explanation
	Following materials have to be ready on the table:

	- Pen - Pencil - 2x consent form - Demographic Form - Prior Knowledge Questionnaire - Mental Effort Questionnaire - Gained Knowledge Questionnaire - Laptop with two windows for each video
5 minutes	Welcome, and thank you for your time and deciding to take part of this experiment. I am Roseidys Primera, master student educational science and technology. This experiment will consist of video-watching and filling in questionnaires and in some cases performing a task after video watching. This study is part of my MSc thesis and will focus on exploring the effects of learner- and system control pacing in instructional videos. Learner controls are the use of the play and pause buttons in this study and system control is when the video is pre-segmented in sections and natural pauses are included. You can stop participating at any moment in time and all data that is collected is anonymous, if you want to receive your data, let me know now or at the end of the experiment for you to get a copy of it, because after today your data will no longer be traced back to you. Also, if you want an update of this study and the results, let me know, so that I can write down your email. You will first have to read and fill in two consent forms, one is for you with my contact details as well and one is for me.
5 minutes	Now you can fill in the demographic form and the prior knowledge questionnaire of the Science of Sleep. You cannot ask for help while filling in the prior knowledge questionnaire and you can also not search for help on the internet.
30 minutes	Depending in which group they are allocated to, they will receive a slightly different instruction: Group 1: NO LEARNER-CONTROL WITH CONTINUOUS SYSTEM CONTROL. As soon as you are ready, I will start the video playing for you, after that you cannot pause the video at all, the video will be played in one

	whole go. The video watching will take approximately 25 minutes. Pay close attention to the video. After the video watching you will have to fill in a mental effort questionnaire, it will be now face down on the table, when you are done watching the video, you can fill it in directly. Group 2: SEGMENTED SYSTEM CONTROL. As soon as you are ready, I will start the video playing for you, after that you cannot pause the video at all, the video will be played in one whole go. The video watching will take approximately 25 minutes. Pay close attention to the video. During or/and after the video watching you will have to fill in a mental effort questionnaire, it will be now face down on the table, when you find fitting, you can fill it in. Group 3: LEARNER CONTROL. As soon as you are ready, I will start the video playing for you, after that you can pause and replay the video whenever you find fitting. The video watching will take approximately 25 minutes. Pay close attention to the video. After the video watching you will have to fill in a mental effort questionnaire, it will be now face down on the table, when you are done watching the video, you can fill it in directly. Group 4: SEGMENTED SYSTEM CONTROL & LEARNER CONTROL. As soon as you are ready, I will start the video playing for you, after that you can pause and replay the video whenever you find fitting. The video watching will take approximately 25 minutes. Pay close attention to the video. During or after the video watching you will have to fill in a mental effort questionnaire, it will be now face down on the table, when you find fitting you can fill it in.
15 minutes	You are now going to fill in the gained knowledge questionnaire on the science of sleep. You have to make this questionnaire again with no external help.
10 minutes	You have to now fill in the prior knowledge questionnaire of APA.
10 minutes	Depending in which group they are allocated to, they will receive a slightly different instruction: Group 1: NO LEARNER-CONTROL WITH CONTINUOUS SYSTEM CONTROL. As soon as you are ready, I will start the video playing for you,

	after that you cannot pause the video at all, the video will be played in one whole go. The video watching will take approximately 8 minutes. Pay close attention to the video. After the video watching you will have to fill in a mental effort questionnaire, it will be now face down on the table, when you are done watching the video, you can fill it in directly. Group 2: SEGMENTED SYSTEM CONTROL. As soon as you are ready, I will start the video playing for you, after that you cannot pause the video at all, the video will be played in one whole go. The video watching will take approximately 8 minutes. Pay close attention to the video. During or/and after the video watching you will have to fill in a mental effort questionnaire, it will be now face down on the table, when you find fitting, you can fill it in. Group 3: LEARNER CONTROL. As soon as you are ready, I will start the video playing for you, after that you can pause and replay the video whenever you find fitting. The video watching will take approximately 8 minutes. Pay close attention to the video. After the video watching you will have to fill in a mental effort questionnaire, it will be now face down on the table, when you are done watching the video, you can fill it in directly. Group 4: SEGMENTED SYSTEM CONTROL & LEARNER CONTROL. As soon as you are ready, I will start the video playing for you, after that you can pause and replay the video whenever you find fitting. The video watching will take approximately 8 minutes. Pay close attention to the video. During or after the video watching you will have to fill in a mental effort questionnaire, it will be now face down on the table, when you find fitting you can fill it in.
15 minutes	You are now going to fill in the gained knowledge questionnaire on APA Tables and Figures. You have to make this questionnaire again with no external help.
1 minute	Thank you for participating in my study. If you want to receive updates on the study, please let me know. I wish you a nice day.
Total time:	91 minutes (roughly 1,5 hours maximum)

Appendix I

NC: https://graasp.eu/s/yvmb04

LC: https://graasp.eu/s/bj82gl

SC: https://graasp.eu/s/w15qfn

SLC: https://graasp.eu/s/e3nbi0