The Effects of Implementing Questions and Web Lecture Length on Mind Wandering: A Quantitative Research Study

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Abstract

The Covid-19 pandemic forced universities to work more with online lectures. Pre-recorded lectures are commonly used in a flipped classroom approach. These web lectures, also known as knowledge clips, are essential for proper understanding of the course material and participation in an in-class activity. As students watch the knowledge clips independently and without interaction with the teacher, there is a chance that the students get distracted. This process is called mind wandering. Previous research has shown that the longer the knowledge clip lasts the more mind wandering is observed. The aim of this research is to explore ways to reduce mind wandering while watching knowledge clips. Earlier research indicates that implementing retrieval quiz questions in knowledge clips may have a positive effect on reducing mind wandering. In the present study I investigate both the effect of adding retrieval questions on mind wandering and whether the degree of mind wandering is affected by the length of knowledge clips. A repeated measure two-way ANOVA 2x2 factorial design within subjects factor implementation of questions and within subjects factor video length is used. In this current study, no significant difference was found between the four different groups. However, the highest degree of mind wandering was found in the last part of the Long Afterwards group. This result is in line with previous research.

Keywords: Mind Wandering, Knowledge Clips, Implementation of Questions, Video Length

Mind Wandering During Knowledge Clips

In the beginning of 2020, the Covid-19 pandemic emerged. The increasing restrictions at the time, recommended by the World Health Organization and international institutions for disease control and prevention have profound implications for the way we interact with each other, and for the methods by which teachers teach and students learn and work. During the pandemic it was no longer possible to teach, learn and work with large groups of people physically in classrooms. Teaching was done collectively via internet platforms such as Microsoft Teams with individual students. Previously, not much thought was given to teaching of large groups of people via the internet. As a consequence of the pandemic, this has become a major issue and needs to be addressed now and for the future. Particularly since there is a possibility that the Covid-19 virus will not be eradicated (World Health Organization, 2021). Clearly, this will affect the educational landscape, which includes not only teaching methods but also individual and collective practices about how to teach and work (Campillo-Ferrer et al., 2021). This is particularly relevant to tertiary educational institutions such as universities or colleges, where a wide variety of lesson components, such as lectures, tutorials, or workshops, had to be adapted to the consequences of the global pandemic (Fogg & Maki, 2020). So, it is to be expected that in tertiary education the use of web lectures, pre-recorded lectures and knowledge clips posted in an online environment will increasingly be used to share knowledge.

One of the instructional approaches that uses knowledge clips and pre-recorded lectures is the Flipped Classroom Approach (FCA). The popularity of a flipped learning approach has grown quickly over the past decade and has been applied and researched in a wide variety of educational contexts (Bergmann & Sams, 2012; van Alten et al., 2019). The FCA is designed in a way that students have to study the basic knowledge for a class study subject by means of an online instruction video or other online information before the class begins. As a result, during class there is more time available for projects, discussions, and problem-solving (Van Alten et al., 2019; Lai & Wang, 2016; Missildine et al., 2013). Previous studies have typically focused on questions concerning the relative

effectiveness of online versus face-to-face classroom instruction. Evidence indicated that online learning is often as effective as classroom learning, and that a blend of the two is more effective than either one alone (Means et al., 2010). Nevertheless, researchers in the field of online learning found that learners have difficulty sustaining attention while watching knowledge clips (e.g., Brown, 1927; Khan, 2012). Attention to knowledge clips can sometimes fail, and periods of inattention are frequent preoccupied with self-relevant thoughts unrelated to the content of the current lecture (Smallwood, 2013). This process is known as mind wandering. The student can no longer keep their focus on the clips because it is a complicated or long-winded story where their attention slips further and further away. This can manifest itself in the mind focusing on something else or letting the mind wander. Importantly, once an episode of mind wandering is initiated, performance associated with the task at hand may suffer (Smallwood & Schooler, 2006).

Theoretical Framework

The Flipped Classroom

In recent years, the educational paradigm has shifted from teacher instruction to student-centered learning (Lai & Wang, 2016). Based on this kind of innovation, more technologies have been integrated into education and multiple learning methods have offered students different ways of learning (Lai & Wang, 2016; Yehya, 2021). Among the different learning modes, the FCA is considered a learning method that potentially engages students in applying their knowledge and performing higher order thinking, rather than receiving direct instruction (Davies et al., 2013; Chuang et al., 2016). A FCA means that students acquire the basic knowledge before class so that during class, teachers are able to engage students in more learning activities to apply the knowledge they have learned through practice, discussion, and problem solving in class (Missildine et al., 2013).

He et al. (2016) defined FCA using three characteristics; flipped classrooms should feature: (1) mandatory pre-class learning of new material followed by (2) in-depth explanation, practice, and productive use of knowledge in class through active learning techniques, where (3) class attendance

is mandatory. Pre-class learning is a familiar part of instruction. Before the FCA was studied as a separate pedagogy, teachers were familiar with assigning homework for students to read and complete assignments before class. In traditional classrooms, pre-class learning was often not seen as necessary and teachers would cover the pre-assigned material in class anyway (Lai & Wang, 2016). In the FCA, out of class instruction is used to teach (factual) knowledge that will not be repeated in class, except for a brief review (He et al., 2016). Here it is important to have enough knowledge about a concept to understand the concept in a higher order (e.g., comprehension, application, analysis, synthesis, and evaluation) (Blyth et al., 1966). In a FCA, the pre-class lectures must be understandable and well-constructed as they are a foundation for further learning.

Constructing Knowledge Clips

All three characteristics from the study of He et al. (2016) are required when executing a FCA. I are concerned with how to structure pre-class instruction materials, as referred to by He et al.'s first characteristic. Knowledge clips are an important component in an FCA. Without the knowledge from the clips, the student cannot participate during the in-class activities (He et al., 2016). Therefore, it is important that knowledge clips are well-constructed. Knowledge clips can be constructed in many ways such as TED talks, pitches, animations, and vlogs to provide students with information.

The most common way in higher education is to use the combination of video, audio, and presentation slides streamed over the web (Day, 2008). In the current design of higher education, previously delivered lectures are often used as knowledge clips. Ketterl et al. (2009) describe that these recorded lectures can serve well as knowledge clips. Day et al. 2006 disagree with Ketterl et al. (2009), they recommend recording lectures out of class to keep them short (20–25 minute maximum) or by splitting them up into multiple recordings, so students remain attentive. Risco et al. (2013) concur with Day et al's statement. In their study of attention during a web lecture, they found that when students watched a 60-minute lecture their thoughts wander twice as much as in the

second half of the lecture when compared to the first half. If a knowledge clip lasts longer than 30 minutes, the student's attention span decreases significantly, which presents a problem as attention is essential for gaining new information that can be applied again during an in-class activity. The question is whether recorded lectures are as effective to provide students with information?

Accordingly, an essential aspect of learning is the ability to remain focused for extended periods of time. Scholars have long noted that students have difficulty doing this during lectures (Bruce et al., 2010). The study by Smallwood et al. (2003) in the area of allowing one's mind to wander from task-related thoughts has been operationalized in two terms. The first term is wandering as the tendency of the content of one's mind to wander from an ongoing task to unrelated inner thoughts and feelings (e.g., daydreaming, thinking about one's personal past or future). The second term is task-related interference, the experience of interfering thoughts related to the assessment of an ongoing task (e.g., difficulty or length of the task). The two terms of mind wandering can both occur when a student must independently watch a knowledge clip. The issue with web lectures and knowledge clips is that there is no face to face interaction between a student and a teacher (Ooms et al., 2014). With a lack of face tot face interaction there is an increased chance that minds start wandering, which results in a lack of attention (Schacter et al., 2015).

Combating Mind Wandering

Previous studies have shown that retrieving information from memory can improve the long-term retention of that information (Roediger & Karpicke, 2006). In addition, retrieval testing has been shown to have multiple benefits, for example; students who practice retrieval are better able to transfer their knowledge to answer related questions in new questions in new contexts (Butler, 2010; Duncan et al., 2012). Weinstein et al. (2014) was one of several studies that investigated the effect of retrieval practice on long-term memory. One of the side effects of their study was that the group in which retrieval practice was applied also showed a much lower percentage of mind wandering. Szpunar et al. (2012) and Jing et al. (2016) conducted research on the effect of retrieval practice on

mind wandering. Here, students in the experimental group watched a knowledge clip in which retrieval questions were implemented in the clip. In the control group, these questions were shown at the end of the clip. Szpunar et al. and Jing et al. used only one video. In the experimental group, questions were implemented in the video and in the control group, the questions were asked afterwards. Both studies concluded that implementing retrieval questions in the middle of the video reduced mind wandering.

Szpunar et al. (2012) and Jing et al. (2016) did not look at the difference in effectiveness of the implementation of questions between shorter and longer web knowledge clips. Not much research has been done on the effect of implementing retrieval questions in shorter and longer knowledge clips on the degree of mind wandering. Lagerstrom et al. (2015) found that in recent years a rule has emerged that the shorter the clip, the better students can keep their attention, making it interesting to look at the effect of adding retrieval questions in both short and long videos. However, it can be a challenge to fit all the necessary information into a short clip. There is some debate about what constitutes a long clip and what constitutes a short clip, with some studies suggesting that a short clip should be no longer than 10 to 15 minutes (Bradbury, 2016; Geri et al., 2017) while other researchers indicate that a short clip should be 20 to 25 minutes maximum. (Day et al., 2006; Risco et al., 2013). Nevertheless, adding interactive elements (e.g., retrieval questions) can have a positive effect on prolonging students' attention, and it lowers the chance that students will stop watching the video (Roycroft, 2015; Seaton et al., 2014). Geri et al. (2017) conducted research on the effect of implementing interactive elements to both shorter and longer clips on students' attention span. In this study, 59 Massive Open Online Courses (MOOCs) were used in which the shortest clip was 4 minutes and the longest was 24 minutes. Short videos were under 11 minutes and long clips were over 11 minutes. The results of this study indicate that adding interactive elements to clips has a positive effect on students' attention span. This effect was found in both the short and long videos where a slightly larger effect of adding interactive elements was found for longer video.

Aim of the Present Study

Previous research shows that adding retrieval questions to a knowledge clip can have a positive effect on reducing mind wandering during online educational video's among higher education students. In addition, adding interactive elements to knowledge clips has a positive effect on students' attention span, with a slightly larger effect being found for longer knowledge clips. Therefore, the research question of this study is: *What is the effect of integrating questions in knowledge clips in a flipped classroom approach on student mind wandering? And is the effect the same for longer and shorter web lectures?* In line with the results of the study by Geri et al. (2017), the hypothesis of this study is that implementing retrieval questions will reduce mind wandering in both short and long videos.

Method

Participants

The sample consisted of 82 students, of which 62 were women and 21 were men, all between the ages of 18 and 44. All students studied at Utrecht University during data gathering and followed either the ALPO program (35.4%), a bachelor (34.1%), or a master (26.8%) in Educational Sciences. There were also students from another study program who followed the course (3.7 %).

Research Design

A quantitative study with a causal design using survey methods was conducted to study the effect of adding questions to a knowledge clip on mind wandering, and whether the length of the clip affects the degree of mind wandering. In this study, the following program output is used: the descriptive statistics (mean and DS) and a repeated measure two-way ANOVA 2x2 factorial design with within subjects factors implementation of questions (integrated and not integrated) and within subjects factor video length (< 20 min, > 20 min) (Figure 1 and Table 2). A within-subjects design was chosen to provide all students with comparable educational circumstances during the course.

Instruments

Knowledge Clips and Quiz Questions in the Course DLS-A

During data collection, web lectures from the DLS-A course are used. A total of 25 knowledge clips were used in the experiment; Fifteen knowledge clips with a duration of less than 20 minutes and, eight knowledge clips with a duration of more than 20 minutes. Half of the '< 20-minute knowledge clips' were presented with integrated quiz questions while the other half was presented followed by quiz questions. The same procedure was applied to the presentation of the '> 20-minute knowledge clips'. Therefore, each participant viewed short knowledge clips with implemented questions (Short Implemented), short knowledge clips with questions afterwards (Short Afterwards), long knowledge clips with implemented questions (Long Implemented), and long knowledge clips with questions afterwards (Long Afterwards) (Appendix A). The four-options multiple-choice quiz-questions added to the knowledge clips are made in consultation with the course coordinator (example questions in Appendix B). The number of quiz questions for the knowledge clips ranged from two to seven questions per knowledge clip depending on the length of the knowledge clip.

Mind Wandering Questionnaire

Mind wandering was measured with three questions (Table 1) for both the short and long knowledge clips. For the long knowledge clips, two additional questions were asked, one about the degree of mind wandering in the first part of the clip and another about the degree of mind wandering in the second part of the clip (Table 1). These additional questions were added for the long knowledge clips because Risco et al. (2013) found a higher degree of mind wandering at the end of a long knowledge clip compared to the first part of the clip. The questions used in this study are based on the research of Weinstein (2018) who examined how best to measure mind wandering. When administering the questions, the students completed a 5-point Likert scale; 1 = Never, 3 = sometimes yes / sometimes no, 5 = Always. Number 1 represents experiencing no mind wandering

and number 5 represents experiencing a lot of mind wandering. An uneven Likert scale was used as it gives the participants the opportunity to answer neutrally (Croasmun & Ostrom, 2011).

Table 1

Questionnaire Mind Wandering.

Item	Question	
ITEM1	To what extent was my focus when watching the knowledge clip.	
ITEM2	To what extent did my mind wander while watching the knowledge clip.	
ITEM3	To what extent did I think about other things while watching the knowledge clip.	
ITEM4	My mind wandered in the first part of the knowledge clip.	*
ITEM5	My mind wandered in the last part of the knowledge clip.	*

Note: *Only used after long knowledge clip

Reliability

To chart the reliability of the questionnaire, the internal consistency was measured with a Cronbach's alpha. The alpha was calculated for the four groups and can be found in Table 2. The alpha's of the questionnaire for the short knowledge clips are negative. This has implications for the interpretation of the results. Because the Cronbach's alpha indicates that internal consistency is negatively related.

Table 2

Reliability Calculated with the Cronbach's alpha (α).

Groups	α
Short Implemented	-.790
Short Afterwards	-.311
Long Implemented	.36
Long Afterwards	.34

Procedure

The data was gathered during the Developing Learning Situations-Advanced (DLS-A) course. Watching the knowledge clip, answering the questions, and completing the questionnaire on mind wandering are conducted in an online environment. The native language of the participants is Dutch, for this reason the instruments are offered in Dutch which increases the validity of the given answers (Wong & Wang, 2008). Attending the course is mandatory for participants, but participation in this study is voluntary and active informed consent was obtained from all participants prior to the experiment. The experiment takes place during the course: DLS-A. Each week, for a duration of eight weeks, students watched and completed the knowledge clips with the accompanying questionnaires. Each week the knowledge clips with the questionnaires were made available to students on Tuesday and closed again on Friday. After the student has watched a knowledge clip, they are asked to fill out a questionnaire about the extent to which they experienced mind wandering while watching the knowledge clip (Table 1 and Dutch version in Appendix C). Students could click through to the questionnaire about mind wandering immediately after the knowledge clips so that the student could remember their amount of mind wandering (Weinstein, 2018). The data was saved in an online data storage environment, to which only the researcher had access.

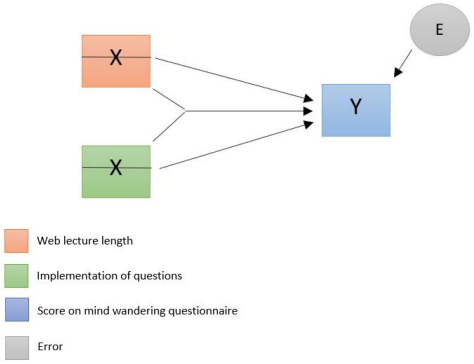
Data Analysis

In order to answer the research question, a two-way ANOVA repeated measure analysis will be performed with the score on mind wandering questionnaire as a dependent variable and implementation of questions and web lecture length as independent variables (Figure 1). The program SPSS (version 26) is used to analyze all the data. In this study the following program output is used: the descriptive statistics (mean, DS, minimum and maximum) and two-way repeated measure ANOVA 2x2 factorial design with within subjects factors implementation of questions (during and after the web lectures) and within subjects factor video length (< 20 min, > 20 min) (figure 1 and table 2). This output is the basis for comparing the results. Prior to the two-way

repeated measure ANOVA, the data was checked for the following assumptions, in order to draw correct conclusions. Correct conclusions can only be drawn if the dependent variable is continuous and normally distributed (normality is measured by the Shapiro Wilk test if the p value is not significant, the assumption is not violated), the repeated measurements were taken at fixed times by all patients and, there are no missing values. The assumption for sphericity was not checked because there were only two levels for each independent variable. A significant difference is found at a $\alpha < .05$. Eta squared (η^2) was also calculated to give a measure of the effect sizes (Field, 2018). Cohen suggested that $\eta^2 = 0.2$ be considered a small effect size, 0.5 represents a medium effect size and 0.8 a large effect size (Carlson, 1988).

Figure 1

Path Model Repeated Measure ANOVA.



Results

Deleted Data

The course was followed by 154 students who gave consent to participate in this study. Each week, students were asked to complete the questionnaire on mind wandering after watching a knowledge clip. At the end of the course and experiment, 82 students had completed all questionnaires. The students who did not complete all the questionnaires were removed from the data set. In total, there were 25 clips for the students to watch during the course. The first two short

clips were not used in the analysis due to a technical error. The remained 23 knowledge clips were analysed.

Video Speed

At the end of the course, participants were asked at what speed they had watched the knowledge clips. Most participants indicated that they had watched the videos at a normal speed, as shown in Table 3. For the " Different" option, eight students indicated that they watched the clips twice as fast as compared to the original speed. Two students indicated that they watched the clips at a speed of 1.75 of the normal speed. Two students indicated that they changed video speed for each knowledge clip. Finally, three participants indicated that they had not watched the videos but only answered the questions, these participants were removed from the data set.

Table 3

Students Video Speed While Watching the Knowledge Clips.

Per second	Frequency	Percent
0.75	1	1.2
1	27	32.9
1.25	19	23.2
1.5	23	28.0
Different	12	14.6
Total	82	100.0

Descriptive Statistics

The results of this study are organized is four groups. For each group, the degree of mind wandering is shown in Table 4. Percentage 1 represents no wandering and percentage 5 represents a lot of wandering was experienced. The first group consists of the short videos with questions implemented (Short Implemented), the second group consists of the long videos with questions implemented (Long Implemented), the third group consists of the short videos with questions afterwards (Short Afterwards) and, the last group consists of the long videos with questions afterwards (Long Afterwards). Prior to the analysis comparing the four groups, Table 4 shows the descriptive statistics.

Table 4

Descriptive Statistics on the Degree of Mind Wandering Measured with the Mind Wandering Questionnaire for the Four Groups.

	Mean	DS	Minimum	Maximum
Short Implemented (SI)	2.90	.20	2.38	3.46
Long Implemented (LI)	2.87	.29	2.25	3.75
Short Afterwards (SA)	2.89	.18	2.48	3.38
Long Afterwards (LA)	2.90	.31	2.25	3.60

Assumptions

In order to draw the correct conclusions from the within subject design repeated measure ANOVA of web lecture, length and implementation of the mind wandering assumptions were checked. The data set is checked on normality, rated by the Shapiro Wilk test (Table 5) because the *p* value is not significant, the assumption is not violated. The assumption for sphericity was not checked because there were only two levels for each independent variable.

Table 5

Test of Normality, Shapiro Wilk Test

	Statistic	df	*p**
Short Implemented	.970	82	.049
Short Afterwards	.984	82	.388
Long Implemented	.986	82	.521
Long Afterwards	.989	82	.714

Note. *The mean difference is significant at the .05 level.

Repeated Measure ANOVA

A 2x2 factorial ANOVA repeated measure analysis was used to test whether there is a difference in the degree of mind wandering between short and long videos (Length) and when questions are presented during or after the video (Implementation). The results show that no significant effect was found for the factor implementation on the degree of mind wandering and no significant effect was found for the factor knowledge clip length on the degree of mind wandering. In addition, no significant interaction effect is apparent. The results can be found in table 6.

Table 6

ANOVA 2x2 Factorial Design with Within Subjects Factors Implementation and Within Subjects Factor Video Length on Mind Wandering

Source	df	SS	SM	F	*p**	η^2
Implementation	1	.05	.50	.85	.36	.01
Length	1	1.90	1.90	.00	.99	.00
Implementation * Length	1	.09	1.00	1.59	.21	.02
Error (Implementation)	81	4.72	.06			

Error (Length)	81	4.41	.09
Error (Implementation * Length)	81	5.04	.06

Note. *The mean difference is significant at the .05 level.

First Part versus Last Part

In the current study, students were asked at the end of a long knowledge clip what their degree of mind wandering was in the first part of the knowledge clip and the last part of the knowledge clip. The highest degree of mind wandering was found in the last part of the knowledge clip in the Long Afterwards group. The descriptive statistics for these results are shown in Table 7.

Table 7

Descriptive Statistics on the Degree of Mind Wandering for Amount of Mind Wandering at the Beginning and At The End of Knowledge Clips For Long Videos.

	Mean	DS	Minimum	Maximum
LI first part * **	2.51	.53	1.25	3.75
LI last part * ***	2.92	.53	1.75	4.25
LA first part * **	2.61	.57	1.25	4.25
LA last part * ***	3.10	.59	1.50	4.25

Note. * only from long knowledge clips **descriptive statistics for the degree of mind wandering in the first part of het knowledge clip *** descriptive statistics for the degree of mind wandering in the last part of het knowledge clip.

Discussion

This study measures the extent to which a student's mind wandering differs between shorter and longer videos and when the questions in the videos are implemented during or after the videos. The first finding of the within design repeated measurements ANOVA shows no significant difference between the four groups; Short Implemented, Long Implemented, Short Afterwards and Long Afterwards. This result is not in line with previous research. The study of Geri et al. (2017) indicates that when interactive elements (e.g., retrieval questions) are added to knowledge clips students' attention span will increase. For the study by Geri et al. (2017), students' levels of attention were measured at 59 MOOCs. Here, the degree of attention was not measured over multiple times for the same students. In the current study, a repeated measure ANOVA was performed and no significant difference was found between the groups. In a repeated measures analysis, participants are measured in the same way several times. It may be that the effect of adding interactive elements (e.g., retrieval questions) to knowledge clips flattens out over a longer period of time, or that time-related effects, such as physical and mental changes for participants, can occur and can influence the results (Hedeker et al, 1999). This could explain why Geri et al (2017) did find a significant effect in his study and no significant effect was found in this study.

The second finding of this research is that there is no significant difference in the extent of mind wandering when retrieval questions are implemented before or when retrieval questions are presented after the knowledge clip. The highest degree of mind wandering was found at the end of a long knowledge clip where the questions were asked afterwards. Szpunar et al. (2012) and Jing et al. (2016) both did find a significant difference in the degree of mind wandering between the group with implemented questions and the group with the questions presented after the knowledge clip. The degree of mind wandering was lower in the group that received the knowledge clips with the implemented questions. The studies of Szpunar et al. (2012) and Jing et al. (2016) used an experimental group and a control group. In the current study, a within subjects design was used. A within subjects design was chosen to ensure all students had comparable educational circumstances during the course. All participants performed all four conditions, an advantage of this method is the

absence of effects related to differences in participant characteristics, because the same participants are tested multiple times. A disadvantage of the within subjects-design is that carryover effects can occur. An example is the learning effect where the student becomes familiar with the study or task during an earlier condition and will perform better during later conditions. Or the order effect where the ranking of conditions in a particular order can matter. For example, participants may not pay as much attention during the last condition as they did during the first, because they become tired or bored. And finally, the sequence effect, meaning the interaction between conditions (based on the sequence) can affect the outcomes (Hedayat & Stufken, 2003). These effects could have influenced the results of the study.

Lastly, this research found no significant effect on the extend of mind wandering between longer and shorter knowledge clips. Nevertheless, a small difference can be seen in the degree of mind wandering at the beginning of a knowledge clip compared to the last part of the knowledge clip. Here, the highest degree of mind wandering was found to be recorded in the Long Afterwards group. This is in line with the Research of Geri et al. (2017). Here they did find a significant difference. This is consistent with the trend described by Lagerstrom et al. (2015) where the shorter the knowledge clip, the lower the extent of mind wandering. However, as mentioned earlier, the dividing line between short and long videos is unclear. Some researchers indicate that a short video should be no longer than 10 to 15 minutes (Bradbury, 2016; Geri et al., 2017) while other researchers indicate that a short video should be no longer than 20 to 25 minutes (Day et al., 2006; Risco et al., 2013). The current study assumed <20 minutes is a short video and >20 minutes is a long video. For a subsequent study, it might be interesting to make the short knowledge clips around 10/15 minutes as recommended by Bradbury (2016) and Geri et al. (2017).

Limitations

There were technical problems at the beginning of the experiment. Students could not always get access to the platform where the knowledge clips could be watched. This caused

dissatisfaction among the students, which may affect their motivation to participate in the research. Another limitation of the experiment which might have influenced the results is that some students indicated that they did not watch the knowledge clip but only clicked through to the quiz questions and the questionnaire. The students who indicated this were removed from the data set. Indeed, there may also be some students who only completed the quiz questions and questionnaire but did not indicate this. For follow-up research, it is recommended that students participating in the experiment be monitored even more closely when conducting the experiment and completing the questionnaire.

In addition to practical limitations, the way mind wandering was measured in this study can be questioned. In the current study, a questionnaire on mind wandering was used based on research by Weinstein (2018) who attempted to optimally measure mind wandering. The questionnaires reflect a low or negative Cronbach's alpha which means that the results from the study cannot be properly interpreted. For further research, it is recommended that more research be done on measuring mind wandering with a questionnaire and that a new questionnaire should be developed. In addition, Billig (2013) criticizes the use of artefacts such as questionnaires and experiments in social science. He says it is substantiation of a description (noun for a process) and that the objects in social psychology are theoretical constructs and not real phenomena. As described earlier, it is recommended for subsequent research that more extensive and frequent monitoring of participation, and quality of work of the students participating in the study be conducted. In addition, with the information of Billig's (2013) study, the question can be asked whether using only a questionnaire is enough to measure mind wandering. Using an additional way of measuring mind wandering besides a questionnaire would be valuable, e.g., the eye movements students make while watching a knowledge clips.

Conclusion

In this study, no significant difference was found between the four different groups that were analysed. The highest degree of mind wandering was found in the last part in the Long Afterwards group with no significant effect. Previous research also shows a higher degree of mind wandering with a longer video or when quiz questions were asked afterwards (Geri, 2017; Jing et al., 2016; Szpunar et al., 2012). This study shows that you do not always find a significant difference in the degree of mind wandering and that the concept of mind wandering is sometimes difficult to capture in a questionnaire. The study also indicates that the method can be decisive for the result. Many more factors influence mind wandering, factors which may not be effected by simply adding questions to knowledge clips. Billig (2013) questions the outcome of the type of experiment conducted in this study. He says "The purpose of the experiment is not to find out what the people in the experiments actually do, but it is to see the effects of the main experimental variables on other variables" (Billig, 2013, p. 187). The results of this study may prompt more research on mind wandering in knowledge clips and how it can be reduced. This information can be used by teachers who practice the Flipped Classroom approach and work a lot with knowledge clips to reduce mind wandering among their students. These teachers may choose to add retrieval quiz questions to already existing knowledge clips. Further research is needed to identify all the factors that can contribute to the continuation of mind wandering when watching knowledge clips. Also, the testing of additional methods that measure mind wandering are advised to obtain a better understanding of how the factors influence mind wandering. This will enhance the development of knowledge clips that will more effectively contribute to reducing mind wandering.

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Appendix A –

Division of Web Lectures and Planning

Short Intergraded	1. Chapter 3 (17.32) 2. Chapter 5.1 (08.57) 3. Chapter 5.2 (12.57) 4. Chapter 8.1 (13.38) 5. Chapter 8.2 (11.22) 6. Chapter 11.1 (14.00) 7. Chapter 11.2 (09.49) Chapter 16 (19.40)
Short Afterwards	1. Chapter 6.1 (19.05) 2. Chapter 6.3 (16.38) 3. Chapter 13.2 (09.51) 4. Chapter 9.1 (11.02) 5. Chapter 9.2 (12.39) 6. Chapter 12.1 (14.49) Chapter 12.2 (05.09)
Long Intergraded	1. Chapter 2.1 (23.03) 2. Chapter 13.1 (36.40) 3. Chapter 7 (26.40) Chapter 15 (30.18)
Long Afterwards	1. Chapter 4 (26.09) 2. Chapter 6.2 (20.45) 3. Chapter 14 (23.27) 4. Chapter 10 (33.48)

Week	Web lecture 1 + length	Web lecture 2 + length	Web lecture 3 + length	Web lecture 4 + length	Web lecture 5 + length
1	Introduction				
2	Chapter 1 11.34	Chapter 2.1 23.03			
3	Chapter 3 17.32	Chapter 4 26.09			
4	Chapter 5 08.57	Chapter 5 12.57	Chapter 6.1 19.05	Chapter 6.2 20.45	Chapter 6.3 16.38
5	Chapter 7 26.40	Chapter 8.1 13.38	Chapter 8.2 11.22	Chapter 9.1 11.02	Chapter 9.2 12.39
6	Chapter 10 33.48	Chapter 11.1 14.00	Chapter 11.2 09.49	Chapter 12.1 14.49	Chapter 12.2 05.09
7	Chapter 13.1 36.17	Chapter 13.2 09.51	Chapter 14 23.27		
8	Chapter 15 30.18	Chapter 16 19.40			

Appendix B

Example Retrieval Questions Course Week 1

Web lecture	Question (s)
	- **Week 1**
Chapter 1	**Complex leren**
	1. Welke 3 factoren zijn nodig voor complex leren? (02.48)
	- Integratie, Coördinatie ,Transfer
	- Compartementalisatie, Fragmentatie, Transfer paradox
	- Segmentatie, simplificatie en fractionatie
	- Intrinsic factors, extraneaous factors, germane factors
	Holistisch vs atomistische ontwerp benadering
	2. Welke gevaar kan er ontstaan wanneer je een atomistische ontwerpbenadering gebruikt? (08.10)
	- Compartementalisatie
	- Part-task practice
	- Overlearning
	- Cognitive overload
	4 componenten (gaan over het instructie ontwerp model)
	3. Welke stelling over de 4 componenten van het 4C/ID model is waar: (09.30)
	- De 4 componenten gaan over het instructie ontwerp model
	- De 4 componenten gaan over het ontwerpen van een instructie model.
	- A is waar
	- B is waar
	- Beide zijn niet waar
	- Beide zijn waar
	4. Uit welke 4 componenten bestaat het 4C/ID model? (11.34)
	- Leertaken, procedurele informatie, ondersteunende informatie, deeltaak oefening
	- Taakklassen, leertaken, deeltaakoefening, practice items
	- Leertaken, procedurele informatie, ondersteunende informatie, assessment instrument
	- Analyse, design, development, implementation
Chapter 2.1	**componenten (gaan over het instructie ontwerp model)**
	5. Van welke component wordt hier de definitie gegeven?: De theoretische achtergrond van een taak. (04.19)
	- Leertaken
	- Procedurele informatie
	- Ondersteunende informatie
	- Deeltaakoefening
	EN

6. Van welk component word hier de definitie gegeven?: De component die wordt gebruikt om de uitvoering van routine taken te optimaliseren. (04.19)

- Leertaken
- Procedurele informatie
- Ondersteunende informatie
- Deeltaak oefening

Compartimentalisatie

7. Welke stelling over compartimentalisatie is waar? (07.13)

a. Door authentieke en realistische leertaken te ontwerpen met voldoende variatie zoals in het echte leven, bevorder je transfer.
b. Compartimalisatie houdt intergratie van kennis, vaardigheden en attitude tegen.

- A is waar
- B is waar
- Beide zijn niet waar
- Beide zijn waar

Fragmentatie

8. Wat is een mogelijke uitdaging waar een instructie ontwerper mee om moet gaat als hij alleen maar gebruik maakt van een hele taak? (12.08)

- Een complexe leertaak behapbaar maken voor een beginner.
- Zo veel mogelijk informatie beschikbaar maken tijdens het werken aan een leertaak.
- Een complexe leertaak behapbaar maken voor een expert.
- Te veel trasnfer berieken na het werken aan een leertaak.

Transfer paradox

9. Welke definitie is juist over de transfer paradox? (13.19)

- Een efficiënte training kunnen zorgen voor een lage transfer. Inefficiënte trainingen kunnen zorgen voor een hoge transfer.
- Inefficiënte trainingen kunnen zorgen voor een lage transfer. Efficiënte trainingen kunnen zorgen voor een hogere transfer.
- Een duur training kan zorgen voor een lage transfer. Interval trainingen kunnen zorgen voor een hoge transfer.
- Interval trainingen kunnen zorgen voor een lage transfer. Duur trainingen kunnen zorgen voor een hogere transfer.

Non-recurrente en Recurrente vaardigheden

10. Bij welke type vaardigheid is een hogere transfer noodzakelijk? (22.04)

- Recurrente vaardigheden
- Non-recurrente vaardigheden
- To-be-automated vaardigheden
- Routine vaardigheden

Appendix C

Questionnaire Mind Wandering in Dutch

Nummer	Vraag	
ITEM1	In welke mate lag mijn focus bij het kijken van de kennisclip.	
ITEM2	In welke mate dwaalde mijn gedachte af tijdens het kijken van de kennisclip.	
ITEM3	In welke mate heb ik aan andere dingen gedacht tijdens het kijken van de kennisclip.	
ITEM4	Mijn gedachte dwaalde af in het eerste deel van de kennisclip.	*
ITEM5	Mijn gedachte dwaalde af in het laatste deel van de kennisclip.	*

Noot: *Alleen gebruikt na lange kennisclips.