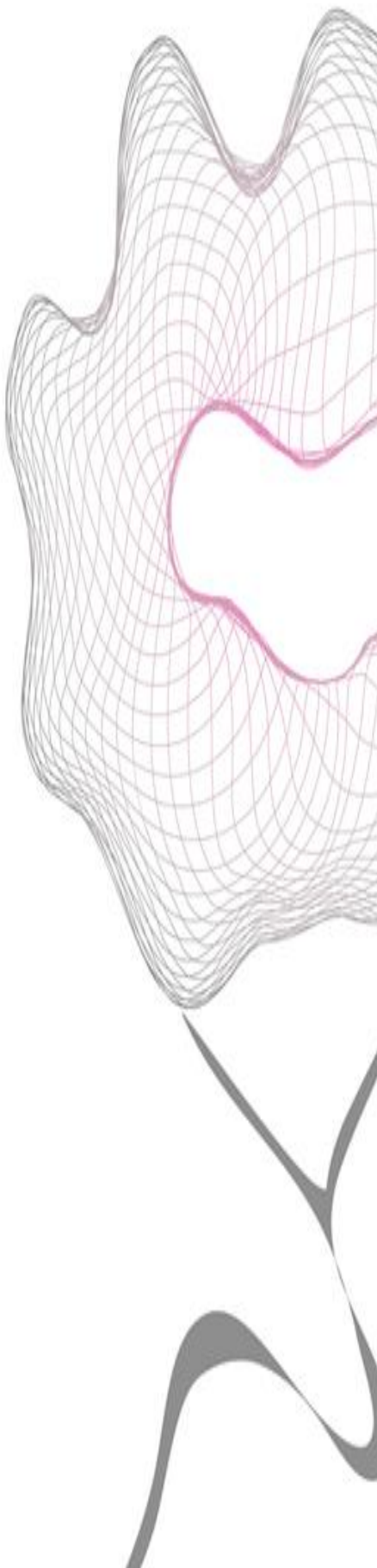


UNIVERSITY OF TWENTE.

*18<sup>th</sup> June 2019*

*Bachelor Thesis*

The Effectiveness of Quizzing in Videos  
and the Mediating Role of Self-  
Regulation in Primary Schools



**Abstract**

Learning videos became more and more popular in the recent years. Often, videos are used in online learning environments, from primary school until graduate levels. However, as the learning process of viewing pure videos is as passive as learning in traditional classes, students do not profit from it. Therefore, adding questions to these videos can increase students' performance and learning achievement. Yet, next to considering effective methods and strategies, students' performance is also dependent on their level of self-regulation. This study investigates how quizzing affects the engagement with learning materials and learning achievements, and the possible mediator role of self-regulation. As individual differences among students in German primary schools can be very large, research in this area is very important. The sample in this study consisted of 41 fourth grade students from two classes. For the intervention, students were randomly divided in two conditions. In the first condition, a video with single-sentence summaries was shown, whereas the video in the second condition (quizzing) had embedded questions. A direct knowledge test and a delayed retention test (after one week) were applied to measure learning achievement. It was found that learning achievement, on both knowledge tests, were significantly better for students in the question condition. No difference was found in time of engagement with the learning material when comparing the two conditions. Therefore, learning videos in primary school would benefit from embedded questions in videos and thus increase the effectiveness of this approach.

### The Effectiveness of Quizzing in Videos and the Mediating Role of Self-Regulation in Primary Schools

In recent years, online learning has become a major topic throughout all educational levels, starting from primary school until university graduate levels. Not only many differences exist regarding educational levels in which online learning is used, but also different types of online learning have been established. It is still a topic of research to consider different methods and strategies, and how to make use of them as a learner, as well as an educator, to make online learning effective. Still, the methods and strategies alone cannot ensure effective learning. In order to profit most from online learning, students should be self-regulated (Williams & Hellman, 2004). This can be specifically of importance when students are not offered guidance and learning engagement is passive. Passive learning without guidance is also a major problem of videos, which are often used as online learning material (van der Zee et al., 2018). Still, research suggests that quizzing can significantly improve learning from videos. Therefore, it is needed to investigate what effect quizzing has in learning videos and whether self-regulation mediates this effect.

Videos are used throughout many different methods of online learning. One of such are flipped classrooms and research on this type shows several benefits, thereby, highlighting the importance of effectively designed videos. In flipped classrooms, “events that have traditionally taken place inside the classroom, now take place outside the classroom and vice versa” (Lage, Platt & Tregia, 2000, p.32). On the contrary, in traditional classes, students, who might not be able to understand or need more time to understand the materials are disadvantaged. These students cannot engage equally well as other students and, also, do not profit from learning activities that follow. Thus, students in flipped classrooms have the possibility to study materials at home and progress in their own pace, which makes it a crucial benefit. Using this method, all students will, at best, enter the class with the same level of understanding and be able to engage equally well in learning activities.

Flipped classrooms and quizzing in learning videos are yet studied mostly in secondary schools, high schools, and at universities. However, they can also occur in primary schools, but here research is limited. Karampa and Paraskeva (2018) found that flipped classrooms in primary schools increased the engagement of students with the materials and the students’ comparative thinking skills increased. In the design of flipped classrooms students’ general learning processes should also be considered (Karampa and Paraskeva, 2018). After finishing 4<sup>th</sup> grade (end of primary school), students in Germany are directed to three different types of schools (Gymnasium, Realschule, and Hauptschule) according to their academic performance.

Therefore, individual differences can be very large in primary schools, in which learning videos in flipped classrooms can be a valuable opportunity. As online learning is also used in German primary schools, flipped classrooms might be preferable as they can be very helpful for those students who need to progress in their own pace in order to understand certain topics.

This study aims to extend the field of research on quizzing in learning videos and yield new results which could help making efficient use of them. Results could indicate how learning performances in primary school children can be increased and how their full potential can be reached. Students' self-regulation skills could be mediating the effectiveness of quizzing in learning videos. In order to see how learning by quizzing is affected, a video with embedded questions will be compared to a group of students who view single-summary sentences after each video.

### **Quizzing in Learning Videos**

Videos are usually the basis for online learning environments. However, videos merely require interaction which leads to passive learning. Thus, videos may need further stimuli to yield learning. This could be achieved by integrating quizzing, as students would need to be more actively engaged with materials (van der Zee et al., 2018). This way, students are actively involved in the learning process of videos by embedded questions. Moreover, it is argued that students cannot maintain a high degree of attention when viewing videos (Lin, Chen, & Lin, 2018). Videos need to be designed in a way that these disadvantages are eliminated.

In order to make effective use of such videos, studies focused on how quizzing improves learner achievement and have shown that quizzing in video lectures has a positive learning effect. Comparing quizzing to non-quizzing, several studies found similar results indicating that students benefit from quizzing and achieve better learning outcomes (Baepler, Walker, & Driessen, 2014; Gier & Kreiner, 2009; Khanna, 2015; Vural, 2013). This improvement was also explained by an increase of attentiveness and engagement (Christiansen, Lambert, Nadelson, Dupree, & Kingsford, 2016). Moreover, it was found that students had a positive attitude towards online videos, and quizzes were valued by the majority (Jolley, Wilson, Kelso, O'Brien, & Mason, 2016). Particularly, online videos that integrate embedded questions promote learning in students and better test outcomes are yielded (Lawson, Bodle, Houlette, & Haubner, 2006; Vural, 2013). These embedded questions have another advantage through are guiding the learner (Lawson et al. 2006). Altogether, having mere videos as learning material is not advantageous, but adding questions or quizzes is shown to enhance learning.

### **Self-Regulation**

Self-Regulation is known and defined by multiple theories. In this study, the concept of self-regulation is mainly based on the definition of Bandura and supplemented by Zimmermann. One of the most known is Bandura's definition of self-regulation in social cognitive theory. According to this theory, self-regulation is grounded in three principles which build up on each other: self-observation, judgmental process and self-reaction (Bandura, 1991). First, during the self-observation, self-monitoring takes place. Self-monitoring means that one's performance is analysed, including when it is likely to appear and what effects it has. In the judgmental process of self-regulation, one's behaviour is judged regarding one's own personal standards. In the last process of self-regulation, the self-reaction, it is decided on how to react on one's own behaviour. Therefore, a self-regulated learner can accurately monitor one's own behaviour, observe one's own thoughts and performances leading to a self-directed change (Bandura, 1991). Bandura also found that effortful performance increases depending on how high one's goals are, and strongly connects his theory to the concept of self-efficacy. Therefore, students who set high goals will engage in more effortful performance compared to students with none or lower goals (Bandura, 1991).

According to Zimmerman, a self-regulated learner can "personally initiate and direct his/her own efforts to acquire knowledge and skill" (Zimmerman, 1989, p.329). It is also believed that self-regulation comprises an interplay of cognition and learning (Duncan & McKeachie, 2005). This social-cognitive view also suggests that motivation and learning strategies can be acquired with time and regulated, rather than being a stable characteristic of a person (Duncan & McKeachie, 2005). Self-regulation is an important construct in students' successful academic performance and a predictor of academic success (Zimmerman, 1989, Bandura, 1991, Williams and Hellman, 2004). Self-regulated students can set goals, monitor their progress towards these goals and adapt strategies when the progress is not as intended (Williams & Hellman, 2004). Moreover, it is suggested that self-regulation can be more critical to academic success in online learning environments, in which students have a greater possibility to use self-regulation skills (Williams & Hellman, 2004). Self-regulation is shown to be an important process in students' learning and might be even more necessary in online learning.

### **Present Study**

None of the previous studies has investigated the effect of quizzing in learning videos and the mediating effect of self-regulation skills in primary school children. Therefore, this experimental study will investigate the effect of quizzing on learning performance and

knowledge acquisition and the role of self-regulation. In this research, a between-subjects design is applied. Independent variables are tested upon different entities and a dependent variable (self-regulation) is being analysed for a mediator effect. This quasi-experimental design consists of two conditions. Next to the embedded question condition (quizzing), a summary sentence condition exists, in which students, rather than viewing nothing, view a single sentence summary of the video. This was decided based on consideration of the large number of researches which have found significant effects of quizzing compared to non-quizzing in videos. Single sentences as stimuli in between the videos could yield different results and have never been studied previously. For both conditions, this is a two-part study, which consisted of conducting the experiment in the first part and completing a delayed retention knowledge test after one week. The delayed retention test is crucial in order to analyse if the acquired knowledge is stored in long-term memory in both conditions. It will be explored whether the question condition also engages longer with the video and acquires more knowledge than the summary condition, as previous studies have shown a positive effect of quizzing compared to non-quizzing. Further, it is expected that self-regulation mediates this effect. Students who are more advanced in self-regulation will learn more than students with less developed self-regulation skills. Thus, the following research question will be investigated: What effect do embedded questions in videos have on students' performance and knowledge acquisition, and is self-regulation a mediator?

The hypotheses are formulated as follows:

1. Students in the embedded question condition engage longer with the learning materials and achieve higher knowledge test scores when compared to the summary sentence condition.

As prior research has given strong support that quizzing enhances longer engagement and leads to better learning performances when compared to non-quizzing, this is also predicted to be similar for the comparison of quizzing to summary sentences, as they are less engaging.

2. Self-regulation mediates learning from videos and the effect is stronger in the summary sentence condition, measured by engagement with learning materials and knowledge test scores.

Based on prior research on self-regulation, it is reasonable to expect that self-regulated students will be more engaged with the learning materials. This relation might be stronger in the unguided condition (summary sentences) as was suggested by Williams & Hellman (2004).

Next to these hypotheses, data will be explored, and a correlation is expected between the knowledge tests.

## Methods

### Participants

The study was conducted in a German primary school with a sample of 41 fourth grade students of two classes. The school was located in a rural area of North-West Germany. The participants' ages ranged from 9.2 to 11.9 and the average was 10.3 ( $SD=.60$ ), see Table 1.

Table 1

*Participants' Age by Condition in Months*

|                      | Min | Max | M      | SD   |
|----------------------|-----|-----|--------|------|
| Summary              | 113 | 143 | 125.33 | 8.61 |
| Sentences ( $N=21$ ) |     |     |        |      |
| Questions ( $N=20$ ) | 111 | 134 | 122.65 | 5.29 |

In this sample ( $N=41$ ), there were more female than male students, see table 2. The children's native language was German. All materials created for this experiment were either in German or they were translated. Prior to participation, parents were informed about the study and signed an active consent. Before the start of children's participation, the experimenter explained the study and its procedure, while pointing out that in any case, the children can withdraw their participation when they should feel uncomfortable. Two students were excluded from the data, as the teacher already indicated that they are special needs students. The research was approved by the Ethics Committee of the Faculty of Behavioural Sciences at the University of Twente.

Table 2

*Participants' Gender by Condition*

|                              | Male (%)  | Female (%) |
|------------------------------|-----------|------------|
| Summary Sentences ( $N=21$ ) | 8 (40.0)  | 12 (60.0)  |
| Questions ( $N=20$ )         | 7 (33.3)  | 14 (66.7)  |
| Total ( $N=41$ )             | 15 (36.6) | 26 (63.4)  |

### Materials

**Videos.** The used video was retrieved from YouTube (SchlauMal). It was a learning video for children about plastic in the ocean. Visual demonstrations that were supplemented by audio explanations were presented in the video. The video was fast-paced and addressed several critical issues constituting the problem of plastic in the ocean, such as ways how plastic ends

up there and what happens with plastic in the ocean.

The video had a length of 4:47 minutes but was segmented in four parts for creating the embedded questions condition and summary sentence condition. Hence, the first part of the video had a length of 1:46min, the second 1:12 min, the third 0:55min, and the fourth 1:04 min. In the summary sentence condition, each part ended with a single-sentence summary of the previously explained aspect. For example, the first part explained the reason why plastic is a problem, therefore, the summary sentence was stated like following: “Plastic is a problem due to its eternal durability”. The experimental condition was shown questions instead of summary sentences and had to answer them on an extra paper sheet. Similarly, the questions were based upon what was explained earlier in the video. The fourth part, for example, explained the different processes of plastic in the ocean, and children in the question condition were thus asked to list the three processes which occur to plastic in the ocean. Table 3 shows the summary sentences and embedded questions.

Table 3

*Embedded Questions and Summary Sentences*

| Videos  | Summary Sentences   | Embedded Questions  |
|---------|---|---|
| Video 1 | Plastic is a problem due to its eternal durability.             | Why is plastic a problem?   |
| Video 2 | Mostly, humans are to blame for plastic getting into the ocean. | On which two ways can plastic get into the ocean?                 |
| Video 3 | There are three processes which occur to plastic in the ocean   | Which are the three processes that occur to plastic in the ocean? |
| Video 4 | Plastic can become a risk for animals and humans.               | How can plastic become a risk for humans?                         |

**Pre-training.** The pre-training consisted of explaining topic-specific words to the students. The words were recognised as perhaps unknown to the students based on their high degree of difficulty and topic-specific nature. The experimenter went through the list of words, one by one. First, the word was read out and students were asked if they know the word and were asked to explain it. When the students indicated that they were familiar with the word read



out, two to three students were picked and given the possibility to explain it. In the end, the definition of the word was read out by the experimenter (Appendix A).

**Tests.** A self-regulation tests was used to identify student's level of self-regulation skills (see Appendix B). This was based on Bandura's Self-efficacy scale (Pajares, & Urdan, 2005) and an adapted version of Paul Pintrich's Motivated Strategies for Learning Questionnaire (Duncan, & McKeachie, 2005). The self-regulation test was originally in Dutch but was translated to German for this study. The test was a self-assessment with 7 Likert items of 7 levels, from very good (=1) to very bad (=7). Thus, a lower level suggests a higher self-regulation ability. The items in this questionnaire addressed self-regulation in learning behaviour and management. One item, for example, was formulated as follows: "How good can you plan your work?". A Cronbach's alpha of  $\alpha=.364$  was found indicating that this is an unreliable measure. Therefore, no further data on SRL will be reported.

Further, two assessments were used to test the children's knowledge acquisition. First, a direct knowledge test about the topic "plastic in the ocean" was created consisting of five open questions ( $\alpha=.530$ ). Four of them addressed each an aspect discussed in one of the four videos. The last question was a general inferential question giving students the possibility to think a step further (Appendix C). Additionally, a delayed retention test of 8 items ( $\alpha=.547$ ) was created to measure the children's knowledge acquisition after one week (Appendix D). Based on that, it could be measured whether information is processed and stored in long-term memory. This delayed retention test consisted of eight open questions, two for each video. In the direct knowledge test, there were two repeat items from the embedded questions. On the delayed retention test all four items were repeated (Appendix E). From the summary sentences one item of the direct knowledge test can be inferred and two items of the delayed retention test. Therefore, in total, two tests were applied to test the children's knowledge acquisition. For the direct knowledge test and the delayed retention test a codebook was created (Appendix F). For every answer a fixed number of points could be achieved. These were counted and contributed to a total raw score of each child.

### **Logging**

Through logging, students' engagement with the videos could be tracked. This is an included tool on the online learning platform "GRAASP". The learning environment with the videos was created on this platform. The video was logged and automatically measured. The reported data included students' total play time of videos, unique play time, and the replay time.

### **Procedure**

On the first day of the experiment, the first class (class A) participated in the first part of the study. The test procedure was explained to the children. Then, the self-regulation test was done on paper in the classroom. Students were given five minutes to complete the test. Then, a pre-training of 10 minutes took place.

In the next step, the class was randomly divided in two by assigning students numbers, either a 1 for the first condition (summary sentences) or a 2 for the second condition (embedded questions). In the first condition, one half of class A, started with the experiment and was asked to follow the experimenter to the computer room. There, students received more detailed information about the exact procedure of the learning video. Thus, the students assigned to the summary sentence condition were told that they will be provided with single-sentence summaries. Overall, they were given 25 minutes to watch and understand the video. Viewing all four videos including either the summary sentences or embedded questions and following the navigation to the next video were estimated to take approximately seven minutes. However, students were given more time so that they could pause the video at any moment and replay parts. Students who had finished with viewing the video, but were still within the 25 minutes, were given an extra task until everyone was finished. This additional task was unrelated to the topic and consisted of students going on the website of an international animal rescue centre, where they were able to see photos, watch videos and learn about non-governmental organisations. After 25 minutes, all students closed the videos or additional tasks on their computer. In both conditions, all students finished in time. Then, students were given a direct knowledge test on paper for which they also had 15 minutes to complete. Then they were asked to go back to their classroom and the second half of class A was sent to the computer room (embedded question condition). They were going through the same procedure, just with adjusted information given prior to showing the video lecture (e.g. that they will be asked questions and that sometimes several answers are possible).

On another day, the second fourth grade class (class B) went through the same procedure. However, this time the sequence of the experiment for the two conditions was changed. Therefore, in class B, the second condition started with going through the video lecture and then the first condition went into the computer room. Thereby, possible benefits of directly viewing the video after having done the self-regulation test and pre-training can be compensated. One week after each class' participation, a delayed retention test was conducted. The students had again 15 minutes for termination.

### **Data Analysis**

First a randomisation check using a chi square test was conducted to see whether the distribution of participants regarding their gender and age are equal. No significant difference was found and therefore, age and gender did not have to be considered as co-variates. In order to test the hypotheses, all variables were examined by using the Shapiro-Wilk test on SPSS. With this test, showing whether the data is normally distributed or not, a decision was made whether to use a parametric (normally distributed) or a non-parametric test (when data is skewed). The logging data was skewed and, therefore, a Mann-Whitney U test was applied to compare the difference of the two conditions. Data on the direct knowledge test and delayed retention test were normally distributed and, thus, one-tailed t-test were conducted on a significance level of .05. Further, a correlation analysis was conducted to find out whether the direct knowledge test relates to the delayed retention test.

## **Results**

### **Randomisation Check**

A randomisation check was performed in order to examine the distribution of participants in each condition regarding their gender. Hence, a cross tabulation with a chi square test was run in SPSS. The results showed that the first condition consisted of 7 males and 14 females whereas the second condition had 8 males and 12 females. The chi-square test indicated that there was no significant difference found in participants distribution to either condition by gender ( $X^2(1, N = 41) = .196, p = .658$ ).

Next, a randomisation check was done to analyse the participants distribution in the two conditions by age. Therefore, a univariate analysis of one-way ANOVA was conducted. Results showed that between the two conditions there was no significant difference in age at the  $p < .05$  level ( $F(1,41) = 1.43, p = .239$ ), see table 2 for descriptive statistics.

### **Logged Data (Videos)**

The video activities were logged to check whether there had been sufficient video engagement. In addition, the logged data afforded a comparison across conditions. Table 3 shows the mean scores for total play, unique play and replays. The data for unique play show that the participants viewed nearly all videos in their entirety. Replays occurred quite regularly with an average score of about 40%. Also, the total play data showed that the average video was set into play mode one-and-a-half time.

Because the data were skewed to the right (not normally distributed), differences between conditions were assessed with non-parametric statistics (Mann-Whitney U test). For all three play measures the results were non-significant, with respectively total play,  $U(41) =$

175,  $z = 0.91$ ,  $p = 0.361$ ; unique play  $U(41) = 256$ ,  $z = 1.21$ ,  $p = 0.227$ , and replay  $U(41) = 219$ ,  $z = 0.24$ ,  $p = 0.811$ . In short, the logged video data showed that video viewing did not differ across conditions.

Table 3.

*Means in Percentages (Standard Deviation) of Video Play Data per Condition.*

|                         | <b>Total play</b> |        | <b>Unique play</b> |       | <b>Replay</b> |        |
|-------------------------|-------------------|--------|--------------------|-------|---------------|--------|
|                         | M                 | SD     | M                  | SD    | M             | SD     |
| Statements ( $n = 21$ ) | 151.5             | (47.0) | 98.7               | (2.6) | 42.9          | (52.1) |
| Questions ( $n = 20$ )  | 161.1             | (42.9) | 96.2               | (6.1) | 33.9          | (36.6) |
| Total ( $n = 41$ )      | 156.2             | (44.7) | 97.4               | (4.8) | 38.5          | (44.9) |

### **Knowledge Tests and Condition.**

First, the data of the direct knowledge test was tested for homogeneity of variance. The Shapiro-Wilk test showed that the data on the direct knowledge test were normally distributed. Hence, a parametric test (one-tailed t-test) was applied for analysing the difference of achieved scores on the direct knowledge test between conditions. There was a significant difference in knowledge test scores across conditions,  $t(39) = -2.63$ ,  $p < .01$  (see Table 4 for descriptive statistics). The question condition had significantly higher knowledge test scores than the summary sentence condition.

Table 4.

*Descriptive Statistics of Participants' Scores on the Direct Knowledge Test in Percentages*

|                             | M     | SD    | Min | Max |
|-----------------------------|-------|-------|-----|-----|
| Summary Sentence ( $N=21$ ) | 29.89 | 19.2  | 0   | 72  |
| Questions ( $N=20$ )        | 47.50 | 14.11 | 6   | 94  |
| Total ( $N=41$ )            | 38.48 | 22.95 | .00 | 95  |

Data on the delayed retention test was also normally distributed and a one-tailed t-test was applied. There was a significant difference delayed retention test scores across condition, which indicated that the question condition scored significantly higher than the summary sentence condition,  $t(39) = -2.39$ ,  $p = .011$ . Table 5 shows the descriptive statistics on delayed retention test scores.

Table 5

*Descriptive Statistics of Participants' Scores on the Delayed Retention Test in Percentages*

|                                  | M     | SD    | Min | Max |
|----------------------------------|-------|-------|-----|-----|
| Summary Sentence ( <i>N</i> =21) | 27.67 | 13.35 | 5   | 51  |
| Questions ( <i>N</i> =20)        | 36.49 | 9.94  | 16  | 49  |
| Total ( <i>N</i> =41)            | 31.97 | 12.49 | .05 | 51  |

### Correlation Analyses

A Pearson correlation analysis was executed to analyse the correlation of participants' total scores on the direct knowledge test and the delayed retention test between conditions. The results show that the mean scores were higher on both tests in the second (embedded questions) compared to the first condition (summary sentences). The analysis showed that the total scores of the tests correlated significantly in the first condition ( $r=.612$ ,  $n=21$ ,  $p<.01/=.002$ ) as well as in the second condition ( $r=.532$ ,  $n=20$ ,  $p<.01/=.008$ ).

### Discussion

In this study the effect of quizzing on learning performance (engagement) and knowledge acquisition in learning videos was researched and the mediating role of self-regulation in this relationship was analysed. Students were compared in two conditions, of which the first viewed the video with embedded questions and the second had single-sentence summaries. Surprisingly, both conditions did not differ in engagement. Still, the second conditions scored better on both knowledge tests. Further, the effect of self-regulation was part of the analyses. However, due to the Cronbach's alpha of the self-regulation measure, data could thus not be reported.

It was expected that students in the embedded question condition, independent of their self-regulation skill level, will engage longer with learning video, measured by video play time, unique play time, and replay time. In fact, no difference was found comparing the embedded question condition to the summary sentence condition on logging data. Prior research has given strong evidence for that quizzing improves engagement with the learning materials and, consequently, their performance (Christiansen, Lambert, Nadelson, Dupree, & Kingsford, 2016). This can be specifically explained in the increase of attention when questions are included. While this can be true when quizzing was compared to non-quizzing, it could not be found in this study where quizzing was compared to summary sentences. For this reason, the finding indicates that summary sentences either, similarly, enhanced engagement or another factor enhanced their engagement with the learning materials.

Further, it was supposed that these students would, due to a higher engagement or self-regulation skills in the question condition also achieve higher scores on the direct knowledge

test. Results have indicated that students in the embedded question condition scored significantly better than students in the summary sentence condition. This is in line with previous research in this area, suggesting quizzing to enhance better learning outcomes (Baepler, Walker, & Driessen, 2014; Gier & Kreiner, 2009; Khanna, 2015; Vural, 2013). Further, Lawson et al. (2006) have shown that guidance by quizzing is an advantage to learning. The results in this study suggest that summary sentences might similarly guide students, but another factor is relevant to learning achievement. As this better performance of the question condition was found despite having no differences in the measurements of engagement, it can be assumed that there is another mediating factor. As self-regulation skills could not be further analysed, it is still assumed that this plays a role. With this result, it can be said that quizzing did enhance learning, but this cannot be explained by higher engagement with the learning materials. There might be another factor explaining this effect.

Another aspect that was hypothesised was that students of the question condition will also score higher in the delayed retention test. This can also be supported with the findings of this study, showing that there was a significant difference between the question condition and the summary sentence condition. The correlation analysis of both tests indicated that the scores correlated significantly in both conditions. Therefore, students in the question condition were also able to retrieve information of the learning videos better from memory than the summary condition after one week.

All in all, students in the question condition did not only perform better on the direct knowledge test but were also able to store information significantly better in long-term memory than the summary condition.

### **Limitations**

There are certain limitations in this study that have restricted the analysis in this study and might have influenced the outcomes. First, the self-regulation data could not be included in our analyses as the scores indicated the measure to be unreliable. This was unexpected as the measure is based on validated instruments. However, the students might have been too young and, thus, items were not completely understood correctly.

Besides, information was given that some of the students had learning disabilities or special needs. These were considered in this study, and two students were deleted from the sample due to visible impacts of the study.

### **Recommendations**

In this study, self-regulation could not be further analysed to the measure's unreliability. Nevertheless, the results in this study also indicate that self-regulation might play a crucial role

in learning from videos. It can be recommended for future studies to take this into account and study more specifically how the benefit of quizzing on performance can be explained. Moreover, it is recommended to conduct such studies with learning videos also in primary school and broaden the field of research in order to effectively design and use learning videos. Further it might be interesting to investigate why summary sentence condition similarly enhanced engagement but was not as effective as questions.

Next to that, future studies in this field could also extend a study like this to a longitudinal study or simply complete a whole flipped classrooms design by also integrating the face to face lesson part including learning activities. Research on students' and teachers' perception of online learning videos have been extensively studied. Yet, they mostly focus on secondary and higher education. Additionally, as students in primary schools are very young it is also considerable to take parents' views on usage of online learning environments into account.

### **Conclusion**

Learning videos offer many possibilities and advantages to learning. Specifically, as this research has shown, which is also in line with previous studies, embedded questions are crucial to learning and are more effective than viewing a video without quizzing. Newly, this study has shown that students in a summary sentence condition engaged equally long as the question condition, but learning was significantly better in students who had embedded questions in the learning videos. Due to the finding that embedded questions enhanced learning, it is suggested to use embedded questions in videos for primary schools.

This study has shown that embedded questions in videos and summary sentences equally enhanced engagement. Videos with embedded questions positively affected learning performance, students acquired more knowledge, and they could retrieve more of it in a delayed retention test compared to students who had viewed single-sentence summaries. Possibly, there is another factor like self-regulation which mediates this effect. Research on the effective design and mediating effect is crucial to education, as online learning is also applied in primary schools and research will contribute to the ability to most effectively make use of them.

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## Appendix A

### Experimenter Script

#### 1.1 Wochen / Tage vor dem Eingriff

- aktive Einwilligung für alle unterschrieben?--> unterschriebene aspeichern für mich selbst und an Lehrer + Management senden
- Die Lehrer senden die Informationen unter Punkt 2 am Montag vor der Intervention
- Die Schüler verteilen nach dem Zufallsprinzip pro Klasse + schreiben Namen mit den Nummern (separates Dokument) + geschichtet nach Geschlecht
- Broschüren drucken, farbiges Papier bedrucken, heften
- Tests mit Nummer
- Zettel je 2 linierte Blätter verteilen
- Erklärung vor Klasse
- Am Mittwoch, die Schule besuchen, Computerraum testen , gucken ob alles vorhanden ist und funktioniert.

#### 1.2 Fragen an:

Lehrer / Informatiker:

- Überprüfen Sie, ob GRAASP und die Videos auf den Laptops funktionieren
- Ob Kopfhörer funktionstüchtig sind

#### 1.3 Kurz vor Beginn der Studie

- Klassenzimmer, Wörter an die Tafel schreiben

#### 1.4 Während der Studie

- Finden Sie heraus, welche Schüler nicht pünktlich fertig sind, und notieren Sie diese
- Überprüfe die Website und ob jeder Schüler sie geöffnet hat
- Nach 15 Minuten wird nochmal gesagt dass sie noch 10 Minuten Zeit haben

#### 2. Vorbereitung für den Lehrer:

##### 2.1 Informationen im Voraus + während

Sie müssen selbst nichts erklären, möchten betreuen?

Möchten Sie beim Verteilen/Abholen helfen?

Möchten Sie bei technischen Problemen helfen?

**Sie können den Kindern inhaltlich nicht helfen.**

Gibt es zusätzliche Computer/Kopfhörer, wenn etwas nicht funktioniert?

##### 2.2 Kurz vor Beginn:

Klassenzimmer:

- Stellen Sie sicher, dass jeder den SR Test vor sich liegen hat
- Jeder hat seinen eigenen Stift + Radiergummi auf dem Tisch

Computerraum:

- Stellen Sie sicher dass der Computerraum aufgeschlossen ist, Lehrer angemeldet
- Stellen Sie sicher, dass alle Benutzer Kopfhörer haben, die Einstellungen richtig sind.

#### 5min. Einleitung:

Hallo. Ich bin xxx, ich studiere Psychologie in den Niederlanden und schreibe gerade meine Bachelorarbeit. Dafür führe ich eine Studie durch bei der ich etwas im Bereich vom Online Lernen testen will. Das Thema von dem Online Unterricht, welches im Rahmen dieser Studie

durchgeführt wird ist Plastik in den Meeren. Dazu werde ich zwei verschiedene Online Lehrmethoden testen, und auch eure Selbst-Regulierungsfähigkeiten.

Erst einmal werden wir nun einen Selbstregulierungstest machen, welchen ich jetzt austeile. Dafür habt ihr ca. 5 min. Danach werde ich euch ein paar Wörter erklären die im Lehrvideo vorkommen da ich mir vorstellen kann dass sie noch nicht allen bekannt sind.

Danach werde ich mit einer Hälfte der Klasse in den Computerraum gehen und ca. 45 min später kommt diese Hälfte wieder zurück und ich nehme andere Gruppe einmal mit.

Wenn wir es nicht zu der regulären Pause schaffen, könnt ihr nach der Studie eine Pause einlegen.

Zettel verteilen!

Bevor ich fortfahre, wollen wir sehen, ob jeder alles hat.

Habt ihr alle einen Stift und den Test vor euch?

Dann gebe ich euch ab jetzt 5 min Zeit. Und bitte schreibt alle eure Namen auf den Zettel.

Letzte Minute einmal sagen: Noch eine Minute Zeit, dann Blätter einsammeln.

Wörter erklären 10min:

Also es sind insgesamt 13 Wörter. Ich schreibe sie alle einmal an die Tafel und werde sie einmal versuchen zu erklären, wenn noch Fragen sind oder ihr ein Wort nach meiner Erklärung immer noch nicht ganz verstanden habt, dann meldet euch einfach, damit wir alle die Wörter am Ende verstehen.

1. Zersetzen

→ Zersetzen bedeutet so viel wie auflösen, wie zum Beispiel Zucker im Tee.

2. Partikel

→ Sehr kleine Teilchen, wenn sich etwas zersetzt bleiben meist kleine Partikel, die dann vll. Auch nicht sichtbar sind, immer noch da

3. Mikroplastik

→ unlösliche kleine Partikel

4. Wegwerfartikel

→ Gegenstände die nach einem Gebrauch wegwerfen werden

Fällt jemandem ein Gegenstand ein auf welches das zutrifft?

z.B. Plastik Strohalme

5. Recycling

→ Wenn man etwas das Müll ist nochmal irgendwie verwendet

6. Illegale Abfallentsorgung

→ Abfallentsorgung? Wisst ihr was das bedeutet? Was bedeutet illegal?

Etwas was gegen die Regeln verstößt, und im Zusammenhang mit Abfallentsorgung, da Müll nicht wie es sollte entsorgt wird

7. Signifikant

→ Das bedeutet so viel wie wichtig!

8. Faser

→ Kleidungsstücke bestehen aus Fasern, könnte Baumwolle, Polyester da gibt es verschiedene Arten. Fasern sind dünne, fadenähnliche Sachen und können entweder von Natur produziert werden oder künstlich aus Plastik

9. Synthetisch

→ Das wären dann künstlich, also aus Plastik hergestellt, synthetische Kleidung beispielsweise besteht dann aus künstlichen Fasern

10. Kläranlage

→ Anlage zur Wasserreinigung

## 11. Chemikalien

→ chem. Stoffe: bspw. Seife besteht aus Chemikalien, also Chemikalien können auch giftig sein

## 12. Strangulation

→ wenn man an etwas fest hängt dann oder erwürgt, nennt man das strangulation

## 13. Ökosystem

→ Beziehungen zwischen Lebewesen, also Menschen, Tiere, Pflanzen und unseren Lebensräumen

Ist das soweit alles klar oder gibt es noch Fragen?

Wenn alles geklärt ist. Dann sage ich jetzt schonmal danke und nehme die erste Gruppe direkt mit in den Computerraum.

Ich muss die Computeranstellen, jeder loggt sich ein mit Namen und Passwort.

Jeder klickt auf den Link im Dokument. Jeder stellt seine Kopfhörer ein.

Dann Erklärung:

Ihr habt 25 min Zeit euch durch dieses Video zu arbeiten, es besteht aus vier Teilen. Ihr könnt selber das Video anhalten oder zurückspulen. Also arbeitet für euch selbst und versucht das Thema zu verstehen.

Wenn ihr fertig seid, meldet euch.

Wenn ihr Probleme habt auch, aber ich kann euch nur bei technischen Fragen helfen.

Nach 15 Minuten werde ich euch sagen, dass ihr noch 10min habt.

Für die die eher fertig sind öffne ich die Webseite vom JRC.

Dann→ Direct knowledge Test

Ich gebe euch dafür 15min Zeit (wenn alle eher fertig sind wird es früher beendet), Schüler gehen in die Klasse zurück, dann erst Pause.

Schüler loggen sich aus, lassen PC an.

Die andere Hälfte der Klasse kommt mit mir mit.

Dann jedem zwei Zettel liniertes Papier geben.

Ihr werdet euch jetzt ein Lehrvideo zu Plastik im Meer angucken und zwischen den Abschnitten wird immer eine Frage gestellt diese sollt ihr auf dem Papier beantworten.

Schreibt vor die Antwort immer die Nummer von der Frage also 1,2,3, 4. Außerdem, ganz wichtig, schreibt eure Namen auf das Papier.

Ihr habt 25 min Zeit euch durch dieses Video zu arbeiten, es besteht aus vier Teilen. Ihr könnt selber das Video anhalten oder zurückspulen. Also arbeitet für euch selbst und versucht das Thema zu verstehen.

Wenn ihr fertig seid, meldet euch.

Wenn ihr Probleme habt auch, aber ich kann euch nur bei technischen Fragen helfen.

Nach 15 Minuten werde ich euch sagen, dass ihr noch 10min habt.

Für die die eher fertig sind öffne ich die Webseite vom JRC.

Dann werden Zettel eingesammelt auf denen die Fragen im Video beantwortet wurden.

Und gleichzeitig wird der Direct Knowledge Test ausgeteilt.

Ich gebe euch dafür 15min Zeit (wenn alle eher fertig sind wird es früher beendet), Schüler gehen in die Klasse zurück, dann erst Pause.

Schüler loggen sich aus, lassen PC an. Ich fahre alle PC's runter.

## Appendix B

### Self-Regulation Test

**Fragen, wie gut du in etwas bist**

**Selbst Ausfüllen**

Beispielfrage:

Wie gut kannst du:

|    |                |             |   |   |   |   |   |                  |
|----|----------------|-------------|---|---|---|---|---|------------------|
| 0. | Tanzen lernen? | Sehr<br>gut |   |   |   |   |   | Sehr<br>schlecht |
|    |                | 1           | 2 | 3 | 4 | 5 | 6 | 7                |

Wie gut kannst du:

|    |   |             |   |   |   |   |   |                  |
|----|---|-------------|---|---|---|---|---|------------------|
| 1. | Deine Arbeit planen                         | Sehr<br>gut |   |   |   |   |   | Sehr<br>schlecht |
|    |   | 1           | 2 | 3 | 4 | 5 | 6 | 7                |
| 2. | Erzählen wie du etwas gelöst hast           | Sehr<br>gut |   |   |   |   |   | Sehr<br>schlecht |
|    |   | 1           | 2 | 3 | 4 | 5 | 6 | 7                |
| 3. | Dich an Erklärungen erinnern                | Sehr<br>gut |   |   |   |   |   | Sehr<br>schlecht |
|    |   | 1           | 2 | 3 | 4 | 5 | 6 | 7                |
| 4. | Dich während des Unterrichtes konzentrieren | Sehr<br>gut |   |   |   |   |   | Sehr<br>schlecht |
|    |   | 1           | 2 | 3 | 4 | 5 | 6 | 7                |
| 5. | Probleme lösen                              | Sehr<br>gut |   |   |   |   |   | Sehr<br>schlecht |
|    |   | 1           | 2 | 3 | 4 | 5 | 6 | 7                |
| 6. | Deine Arbeit kontrollieren                  | Sehr<br>gut |   |   |   |   |   | Sehr<br>schlecht |
|    |   | 1           | 2 | 3 | 4 | 5 | 6 | 7                |
| 7. | Merken ob etwas richtig oder falsch läuft   | Sehr<br>gut |   |   |   |   |   | Sehr<br>schlecht |
|    |   | 1           | 2 | 3 | 4 | 5 | 6 | 7                |

Appendix C  
Direct Knowledge Test

## TEST ZUM THEMA PLASTIK IN DEN MEEREN

NAME: \_\_\_\_\_

1. Wieso ist Plastik ein Problem für die Umwelt?

2. Was sind Eigenschaften von Mikroplastik?

3. Welche 3 Vorgänge gibt es, die mit Plastik im Meer passieren?

4. Warum ist Plastik auch ein Problem für Menschen?

5. Was kann man gegen dieses Problem tun?

Appendix D  
Delayed Retention Test

## TEST ZUM THEMA PLASTIK IN DEN MEEREN

NAME: \_\_\_\_\_

1. Was macht Plastik zum Problem?

/ 1 P

2. Wieso ist Plastik so beliebt?

/ 4 P

3. Wer ist meist Schuld daran, dass das Plastik ins Meer gelangt?

/ 1 P

4. Auf welchen Wegen kann Plastik ins Meer gelangen?

/ 4,5 P

5. Was entsteht aus dem Plastik an Orten wo Meeresströmungen aufeinander treffen?

/ 1 P

6. Welche 3 Vorgänge gibt es, die mit Plastik im Meer passieren?

/ 3 P

7. Wie kann Plastik zur Gefahr für den Menschen werden?

/ 1 P

8. Wieso ist Plastik eine Gefahr für Tiere im oder am Meer?

/ 3 P

## Appendix E

## Tables on Repeat Items

Table 1

*Repeat Items of the Embedded Questions*

| Embedded<br>Questions | Direct<br>Knowledge<br>Test | Delayed<br>Retention<br>Test |
|-----------------------|-----------------------------|------------------------------|
| 1                     |                             | X                            |
| 2                     |                             | X                            |
| 3                     | X                           | X                            |
| 4                     | X                           | X                            |
|                       | X                           | X                            |
|                       | X                           | X                            |
|                       | X                           | X                            |
|                       |                             | X                            |

Table2

*Repeat Items Based on the Summary Sentences*

| Summary<br>Sentences | Direct<br>Knowledge<br>Test | Delayed<br>Retention<br>Test |
|----------------------|-----------------------------|------------------------------|
| 1                    | X                           | X                            |
| 2                    |                             | X                            |
| 3                    |                             |                              |
| 4                    |                             |                              |
|                      | X                           | X                            |
|                      | X                           | X                            |
|                      | X                           | X                            |
|                      | X                           | X                            |
|                      |                             | X                            |
|                      |                             | X                            |



## Appendix F

## Codebook

Direct Knowledge Test

1. Wieso ist Plastik ein Problem für die Umwelt?  
→ Haltbarkeit (1p), etwas abschweifende Antworten: das Enden im Meer/Strand, Gefahr für Tiere und Mensch (1/2p)
2. Was sind Eigenschaften von Mikroplastik?  
Pro genannte Eigenschaft 1p: sehr klein, nicht sichtbar, kann giftige Stoffe aufnehmen
3. Welche 3 Vorgänge gibt es, die mit Plastik im Meer passieren?  
Pro genannten Vorgang 1p → Plastik landet am Strand, und auf dem Meeresboden, oder es schwimmt an der Oberfläche und wird nach und nach durch Sonneneinstrahlung in immer kleinere Teile zersetzt.
4. Warum ist Plastik auch ein Problem für Menschen?  
1p → wir könnten die giftigen Stoffe, durch den Verzehr von Fisch, zu uns nehmen
5. Was kann man gegen dieses Problem tun? (general, not mentioned in video, students need to think further)  
1p → Plastikkonsum verringern

Delayed Retention Test

## First Video

1. Was macht Plastik zum Problem?  
1p → die (ewige) Haltbarkeit
2. Wieso ist Plastik so beliebt?  
1p pro genannte Eigenschaft → leicht, vielseitig einsetzbar, formbar, günstig,...

## Second Video

3. Wer ist meist Schuld daran, dass das Plastik ins Meer gelangt?  
1p → der Mensch
4. Auf welchen Wegen kann Plastik ins Meer gelangen?  
→ Je 1 Punkt für einen richtig genannten Weg:  
- Illegale Abfallentsorgung  
- Von Schiffen  
- Von Quellen an Land  
- Von Müllhalden  
- Durch Wind  
- Vom Strand  
- Durch Mikroplastik in Kosmetik/Duschartikel  
- Durch Abwasser  
- Durch Wäsche/Kleidung in Waschmaschinen

## Third Video

5. Was entsteht aus dem Plastik an Orten wo Meeresströmungen aufeinander treffen?  
1p → Müllteppiche

6. Welche 3 Vorgänge gibt es, die mit Plastik im Meer passieren?  
1p pro genannten Vorgang → Plastik landet am Strand, und auf dem Meeresboden, oder es schwimmt an der Oberfläche und wird nach und nach durch Sonneneinstrahlung in immer kleinere Teile zersetzt.

#### Fourth Video

7. Wie kann Plastik zur Gefahr für den Menschen werden?  
1p → Durch das Essen von Fisch mit Mikroplastik
8. Wieso ist Plastik eine Gefahr für Tiere im oder am Meer?  
1p pro Gefahr → Verwechseln Plastik mit Essbarem, Essen es, Verheddern sich/Strangulation