MASTER'S THESIS

A Matter of Background: How and When Does the Virtual Background in an Instructional Video Impact Learning?

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Award date:
2022

Open Universiteit

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A Matter of Background: How and When Does the Virtual Background in an Instructional Video Impact Learning?

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Course name and course code: Masterthesis OM9906

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Word count: 9968

Date: 26-01-2022

Abstract

Together with the growing use of instructional videos in educational settings, comes an increased demand for concrete research-based principles concerning the design of such videos. This research explored whether a video's background can visually distract students (i.e., affecting their visual information processing) and whether it affects their learning outcomes. In a between-group design, participants (N=47, age 14-17) were assigned to one of three conditions: video with a neutral, authentic, or off-topic background. Their prior-knowledge and working memory capacity (WMC) were measured, eye tracking data was recorded during the learning experience, and afterwards we measured learning outcomes and learning experience. In line with our expectations, the eye tracking revealed that a neutral background distracted the viewers the least, allowing them to pay better attention to relevant parts of the video. Also, learners found the off-topic background to be distracting, however, the negative effect on the learning outcomes did not reach statistical significance. Contrary to our expectations, we did not find a positive effect of the authentic background. Furthermore, the WMC level had a significant impact on visual information processing and learning outcomes. This research concludes that educators should preferably use a neutral background for their learning video's, especially for learners with lower WMC.

Keywords: Instructional video, Virtual background, Eye tracking, Working Memory Capacity

Contents

1. Introduction

1.1 Problem Statement and Research Goal

Even though instructional videos are being used since the early 1900s as a mean to deliver instruction, research on learning from instructional videos only really started to thrive in the past few years (De Koning et al., 2018). This relatively recent sense of a need for knowledge concerning video design, can be explained by the substantial increased use of instructional videos in formal as well as non-formal learning environments (Bétrancourt & Benetos, 2018; De Koning et al., 2018; Merkt et al., 2019). This increased use has taken an even further flight during the Covid-19 pandemic when schools were closed and educators all over the world had to turn to online education, including recording their own instructional videos. The guidelines on how to design these instructional videos are limited (De Koning et al., 2018). Since instructional design based on intuition alone, endangers an efficient and effective learning experience (Neelen & Kirschner, 2020), it is important to offer educators research-based principles for the design of their instructional videos.

As a research area, instructional video design, offers a broad scale of research topics to explore like, how to present the information, the social and emotional effects of videos, or the added value of videos over static images, to name a few (for an overview, see e.g., Bétrancourt & Benetos, 2018; De Koning et al., 2018). Findings of studies concerning some of these topics have already lead to research-based principles for the design of instructional videos, such as the pacing principle or the signaling principle (Mayer, 2010), but there are still a lot more questions that can be asked and answers that need to be found (De Koning et al., 2018).

One of those questions concerns the effect of a video's background on learning outcomes. Online software such as Microsoft Teams or Zoom offer the possibility to choose a

virtual background. By doing so, one prevents the other interlocutors from seeing the actual setting from which one is working or presenting. There can be several reasons why one would choose to change the background image, for instance privacy, a lack of a suitable work area, or personal preferences. Instructors, like teachers who suddenly have to work from home, might also wish to use this option for their instructional videos or online courses. It would be useful to them if there were guidelines concerning background options, so they would know whether it matters which background they use, and if so, which sort of background would be best to choose. The chosen background should, at least, not hamper learning, and preferably, even optimize learning.

To our knowledge up until now the role of an instructional video's setting or background, has only been explored by Merkt et al. (2019). They compared learning outcomes from watching a video that was filmed in front of a white wall, with learning outcomes from watching a video filmed in an authentic setting, which was a greenhouse in their case. They expected to find that the video's setting would affect the learning outcomes, but it turned out that there were no differences between both conditions (Merkt et al., 2019).

Like Merkt et al. (2019), this master thesis investigates the effect of a video's background on learning outcomes, but instead of comparing video's filmed in different environments, we compared home-made instructional video's with different virtual backgrounds. Merkt et al. (2019) defined an *expertise hypothesis* and a *distraction hypothesis*. The expertise hypothesis states that a student pays more attention to an expert. Therefore, a background that could be considered as an authentic environment in which the presenter of the video, in other words the expert, would usually work, could positively affect learning outcomes. The distraction hypothesis on the other hand, states that an authentic background hampers learning since it causes more distraction. The student would pay less attention to the relevant subject matter (Merkt et al., 2019). This master thesis compares these same

conditions, but considering the fact that Merkt et al. (2019) did not find a difference, we also added a third video with an off-topic background in order to find out whether the background matters at all.

Furthermore this research took individual differences in working memory capacity (WMC) into account. This variable reflects the ability of a person to control her or his attention (Rey, 2014; Sanchez & Riley, 2006) and might interfere with the overall effect of the backgrounds. If so, this would be interesting knowledge for a teacher who wants to make a video adapted to a specific student or class. The teacher could take the student's characteristics into consideration to choose the most adequate background.

Finally, eye tracking is used to explore whether and if so, how, a learner's gaze (i.e. his of her visual information processing) is affected by the different backgrounds (Mayer, 2018). The now following sections will elaborate on the theoretical explanations behind the hypotheses of a video's background as a sign of expertise or as a distraction , the impact of WMC as an individual difference variable, and the role of the learner's visual information processing. This will be followed by the research questions and hypotheses, a detailed description of the research, our findings and conclusions.

1.2 Theoretical Frame

1.2.1 A Video's Background as an Indication of Expertise

As already mentioned, this master thesis compared three conditions, a topic-related authentic background, a neutral background, and an off-topic background. These conditions are based on the hypothesis Merkt et al. (2019) investigated. The **authentic background**, is in line with their expertise hypothesis. This hypothesis is based on the assumption that students are more likely to focus on a person who they consider to be an expert, than on a person they consider to be a novice (see, e.g., Cheng et al., 2013). This might be a reason why several studies found

that instruction from an expert, or even a perceived expert, led to better learning outcomes (Hoogerheide et al., 2016; Lachner & Nückles, 2015; Boekhout et al., 2010).

If humans do not know another person, so if they do not know if this person is an expert for instance, they tend to rely on external or observable factors to form an opinion about this other person (Schwarz, 2007). One example of an observable factor could be clothing styles. Morris et al. (1996) showed that students believe teaching assistants who wear formal clothes, to be more intelligent than those who dress informal (Morris et al., 1996). If the effect of clothing is combined to posture, men and women are both perceived as more competent if they dress formal and take on a neutral pose (Gurney et al., 2017). Age is another example of an observable factor. Hoogerheide et al. (2016) found that learning outcomes from instructional videos on troubleshooting electrical circuits, were higher if the instructor was an adult instead of a younger person. Since the only difference between both videos, was the instructor, and considering the videos' topic, they assume that the instructors' age led students to believe that the adult would have more expertise on the subject (Hoogerheide et al., 2016).

Age, clothing and postures are aspects that are directly linked to the instructor, but people are also influenced by the context in which they observe another person (Schwarz, 2007). Wittenbrink et al. (2001) made this clear with their research on spontaneous prejudice in context. They showed that the same Black person was perceived differently, if the background picture was a church interior instead of a street corner. The street corner picture lead to a larger amount of negative automatic responses (Wittenbrink et al., 2001). This shows that people do not only base their judgments about another person on hers or his appearance, but also on the setting, or the background, in which they perceive this person. Therefore we hypothesize that also an instructional video's background could serve as a sign of expertise.

In the introduction we already mentioned that a background would be considered authentic, if it represents the usual work environment of the presenter (Merkt et al., 2019). Seeing the instructor in her or his natural habitat so to speak, would have a positive effect on the perceived expertise, which in turn might have a positive effect on the learning outcomes. The topic of this master thesis' video is a geography lesson on glaciers. The usual work environment of a geography teacher would be a geography classroom. Therefore, we chose a picture of such a classroom as the virtual background for our authentic background video. If the expertise hypothesis is correct, this would be the condition that leads to the best learning outcomes.

1.2.2 A Video's Background as a Distraction

The **neutral background**, is in line with the distraction hypothesis (Merkt et al, 2019). According to this hypothesis, a video's background might be a distraction. This idea finds its roots in the Cognitive Theory of Multimedia Learning (CTML; Mayer, 2009; 2014) and the Cognitive Load Theory (CLT; Sweller et al., 1998; Sweller et al., 2011). The CTML explains how people learn from multimedia presentations such as instructional videos. The theory is based on three assumptions. The *dual-channel assumption* (Baddeley, 1999; Paivio, 1986), which considers that people process incoming verbal and visual information through two separate channels. The *limited-capacity assumption* (Baddeley, 1999; Sweller et al., 2011), which suggests a limit to the amount of information each channel can process at a time. And the *active processing assumption* (Mayer, 2009; Wittrock, 1989) which states that people should actively attend to useful information in order to transfer this information into the working memory. There, the information should be organized after which it can be connected to prior knowledge already present in the long-term memory (Mayer, 2014).

The dual-channel processing ability that humans have, is one of the reasons why instructional videos can be useful tools for learning. However, it is important that the video

design also takes the limited-capacity and active processing assumptions into account, since learning can only take place, if the learner is able to actively process the subject matter. In order to do this, the learner needs to have enough capacity available in the working memory, which is why it is important to avoid putting any unnecessary load on it (Sweller et al., 2019). According to the CLT, there are two kinds of working memory load that a learner has to deal with while learning; *intrinsic* and *extraneaous* (Sweller et al., 1998, 2019). The amount of intrinsic cognitive load is determined by the complexity of the subject matter itself combined with the learners' prior knowledge level. This load has nothing to do with the way how the subject is presented and it cannot be changed. The amount of extraneous cognitive load on the other hand, is related to the instructional procedures or design. This can be changed, for instance by altering the instructional design (Sweller, 2010; Sweller, et al., 2019).

The CTML and CLT have led to numerous design guidelines (see e.g., Mayer, 2008, 2009, 2014; Sweller et al., 1998, 2019). The focus of this master thesis is on the guideline concerning *the seductive details hypothesis* (Mayer et al., 2001). As mentioned earlier, a learner can only process a small amount of information in the working memory. Therefore adding non-relevant input to the learning materials should be avoided since this might take up much needed working-memory capacity. Seductive details are just that, they are interesting but irrelevant details, that are not part of the subject matter. They are only added to the learning material to make the subject and material more appealing to the learner, and thus create interest (Mayer, 2019). Adding an authentic background to an instructional video could also be considered as adding seductive details, since it is not integrated in the subject matter that has to be learned (Merkt et al., 2019).

The overall conclusion of an extensive meta-analysis by Rey (2012) was that seductive details hamper learning. This could be seen in retention as well as transfer performance (Rey, 2012). Mayer (2019), on the other hand, states that research on the effect of seductive details

on learning outcomes shows mixed results (Mayer, 2019), and the study conducted by Merkt et al. (2019) concerning the effect of a video's background on learning outcomes did not show a seductive detail effect. Hence the necessity of testing the distraction hypothesis. If this hypothesis is correct, there would be a seductive details effect for the groups who watch the videos with the authentic or the off-topic background. The neutral condition would lead to the best learning outcomes.

The third background, the **off-topic background**, adds irrelevant details to the video and could therefore be distracting. Furthermore, it has nothing to do with the subject. Therefore it would not serve as a sign of expertise. It might even be a sign of non-expertise since the background is a beach club. If a video's background has an impact on learning, this condition would be likely to hamper learning the most. Figure 1 shows a screenshot of all three video conditions, neutral, authentic, and off-topic.

In order to obtain a more detailed understanding concerning the impact the different backgrounds might have, this master thesis also took individual differences in *WMC* into account. Furthermore, eye tracking was used to obtain information regarding the attention allocation of the learners. In the next sections these aspects will be further elaborated.

Figure 1

Screenshots From the Instructional video Showing Authentic, Neutral, and Off-topic Background

1.2.3 Individual Differences in Working Memory Capacity

Working memory consists of two separate channels that allow people to hold and process verbal and visual incoming information at the same time (Baddeley, 1999; Pavio, 1986). There is also a third component, the *central executive*, which can be seen as a

supervisory system involved in various functions, such as the coordination of the verbal and visual systems and attention control (Wiley et al., 2014; Baddeley & Logie, 1999). The capacity of the working memory is limited, on average, people are only able to maintain between five to seven chunks (Engle, 2002; Mayer, 2014). As previously discussed, it is due to this limited capacity that the CLT stresses the importance of avoiding unnecessary extraneous cognitive load.

There is another slightly different approach to WMC. This is the approach this master thesis will follow when considering WMC as an individual difference-variable. In this view the capacity is not so much determined by the limited number of chunks one can remember, but rather on the ability that one possesses to put the central executive to use and control attentional resources (Engle, 2002, 2018; Shipstead et al., 2015). In this approach, the WMC capacity tells us something about how capable a person is in avoiding distraction, while staying focused on information that should be noticed and retained in order to be further processed (Schipstead et al., 2015). Engle and Kane (2003) state that the difference between individuals WMC is driven by *executive attention*, which they define as: "the ability to maintain stimulus and response elements in active memory, particularly in the presence of events that would capture attention away from that enterprise" (Engle & Kane, 2003).

Since learning, requires active processing, it can be considered a task that largely depends on this executive attention ability, therefore individual differences in WMC might also affect learning outcomes from multimedia learning (Wiley et al., 2014). Several studies on learning from illustrated text, showed that a higher WMC positively affected learning outcomes, especially when seductive details were added (Banas & Sanchez, 2012; Rey, 2014; Sanchez & Wiley, 2006).

This research expected to find a positive correlation between WMC and learning outcomes. Furthermore, we investigated whether WMC has a moderation effect on the

influence of the video's background on learning outcomes. Individuals with a higher WMC might be less affected by a potential negative effect of a distracting background. They might be able to maintain the elements needed in order to process the important incoming information in active memory, regardless of the background. If they are not harmed by a potential negative effect of the background, they might profit more from the potential positive effect brought by the authentic background.

The video's backgrounds and the individual's WMC might also affect the learners' visual information processing. In order to explore the effect of these variables on the visual attention allocation, this master thesis also looked into eye tracking data. The next section will elaborate more on these aspects of the research.

1.2.4 Eye Tracking

Over the years, eye tracking has proven to be a useful methodology to gain insight in the perceptual processing during learning (Mayer, 2010). Tsai et al. (2018) conducted an eye tracking research on the effects of static and dynamic seductive illustrations in a PowerPoint presentation. Their eye tracking data showed that seductive details drew learners' attention away from the relevant pictures in the presentation. (Tsai et al., 2018). Sanchez and Wiley (2006) used eye tracking in their research on WMC and the seductive details effect. They found that participants with high WMC paid less attention to seductive images that were added to a text in Web page format (Sanchez & Wiley, 2006).

Both studies provide insight on the effect seductive details might have on visual information processing. Since their material only consisted of visual input, their assumptions concerning the eye tracking data, are based on the *eye-mind hypothesis.* This hypothesis states that people's gaze fixations, which are the events during which the eye remains still for a certain time (Holmqvist et al., 2011), are closely linked to their focus of attention (Just & Carpenter, 1980).

The assumptions of the current research are also mainly based on the eye-mind hypothesis. However, since the participants in this research process audio-visual material instead of merely visual material, this master thesis' assumptions are also derived from the *time-locking hypothesis* (Tanenhaus et al., 1995) and the *visual world paradigm* (Allopenna et al., 1998). These are based the finding by Cooper (1974), that hearing spoken language affects people's gaze direction. People tend to direct their gaze towards details that are linked to the spoken words they hear (Cooper, 1974). Tanenhaus et al. (1995) then found that eye-movements towards visuals are closely time-locked to words, or parts of words tied to those visuals. Also, listeners tend to use the speaker's intonation as a sort of cue indicating that a new item is going to be introduced (Dahan et al., 2002).

In the videos that are used for this master thesis, the instructor presents multiple PowerPoint slides which appear and disappear in the top left corner of the screen (see Figure 2). The above mentioned findings, implicate that hearing certain words, or detecting changes in the intonation of the speaker, might direct the viewers gaze towards the PowerPoint slides when they appear. Hadar et al. (2016) have shown that the time between the auditory input and the gaze's target hit increases if the cognitive load is augmented (Hadar et al., 2016). If we translate these findings to this master thesis research, that would implicate that viewers in the neutral condition are likely to direct their gaze faster towards the PowerPoint slides and back to the presenter at the suitable time, than the viewers in the non-neutral conditions, provided that the background of the video is considered a distraction.

Hadar et al. (2016) also suggest that their findings might explain differences between auditory input and the gaze target hit that were found in other studies that looked at older adults (Ben-David et al., 2011). Older adults have a reduced WMC, which could have a similar effect as an augmented cognitive load (Hadar et al., 2016). For this research that would implicate that a similar effect might be found if viewers with a higher WMC were

compared to viewers with lower WMC. Within the same video condition the viewers with higher WMC would probably direct their gaze faster towards the appropriate direction than the viewers with lower WMC.

Besides the rapidity with which a viewer directs her or his gaze, this research also looked at differences between the three video conditions and WMC level regarding the focus of attention on the more relevant areas of the video, being the teacher and the PowerPoint slides, and the less relevant area, which was the background. A bigger focus of attention on the background, instead of the relevant areas, could indicate that the background is a distraction comparable to a seductive detail (Sanchez & Wiley, 2006). On the other hand, if the expertise hypothesis is correct, then it would be plausible that a learner pays more attention to the background in order to form an opinion on the instructor's expertise.

Figure 2

Screenshots From One of the Instructional videos Showing a Selection of the PowerPoint Slides

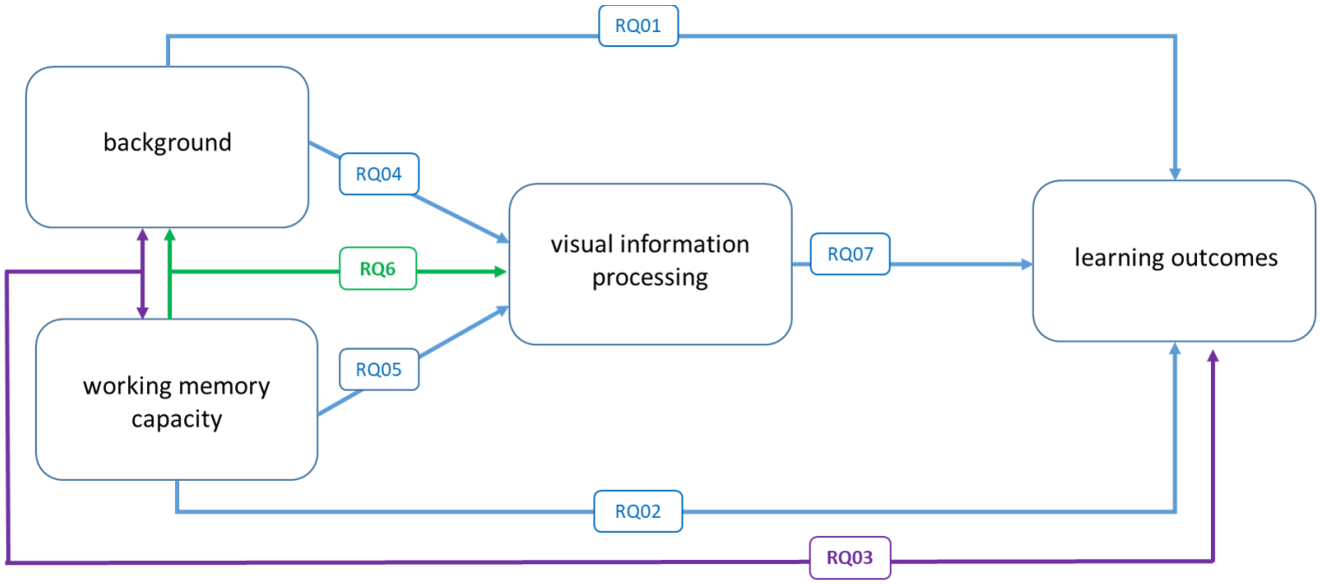
1.3 Research Questions and Hypotheses

Figure 3 offers an overview of the different variables and the research questions. The main purpose of this master thesis, was to investigate whether a background in an instructional video affects learning. Our first research question examined the effect of the background on learning outcomes (RQ1). If the expertise hypothesis (Merkt, et al. 2019) was correct, then the authentic virtual background would lead to better learning outcomes than the neutral and off-topic condition, since it functioned as a sign of expertise (RQ1a). If the distraction hypothesis was correct, than the neutral virtual background would lead to better learning outcomes, because it contained no seductive details that might distract the viewer

(RQ1b). The off-topic condition would make clear if the background mattered at all, since this background contained potentially distracting features that were unrelated to the learning material and it could not provide a sign of expertise (RQ1c).

Figure 3

Conceptual Model Representing the Research Questions



Regarding the influence of WMC on learning, this master thesis expected that a higher WMC would lead to higher learning outcomes(RQ2)[1]. Because of the influence we expected from WMC on the learning outcomes, we also investigated if or how WMC interacted with the different background conditions (RQ3). We checked whether the background condition had an effect on the learning outcomes if we controlled the impact of the WMC (RQ3a), and we investigated whether WMC moderates the relationship between the background condition and the learning outcomes (RQ3b).

The assumption that processing and attention control, including potential difficulties with these, would be reflected in learners' visual information processing, led to the following research questions; Does the video's background affect the learners' visual information

[1] This really is a hypothesis, but to create higher cohesion and ensure better readability, we chose to use the term RQ nevertheless

processing (RQ4), and does the learners' WMC affect the learners' visual information processing (RQ5). The visual information processing consisted of several measurements which were all addressed individually. We investigated whether the video background and the WMC affected the time needed between the teacher verbally referring to a power point slide (i.e.,speech event) and the moment the learner looked at this slide (i.e. his or her gaze hitting the narration congruent area; RQ5a). Besides this rapidity measure, this research also looked at the difference between the three conditions in terms of attention focus (i.e., the amount of time spent looking at the teacher, the PowerPoint slides, and the background, as well as the number of fixations within these three areas; RQ5b). A larger focus of attention to an area in the video, reflected by number of fixations and the total time of the fixations, could either indicate that this area was distracting, or useful and therefore intensely studied. Although a higher number of fixations could also indicate that the viewer had more difficulties finding the necessary information (Ehmke & Wilson, 2007). A larger focus of attention on the off-topic background would probably indicate that it was a distraction (Sanchez & Wiley, 2006).

Our next research question investigated whether the background condition affected the visual information processing if we controlled the impact of the WMC (RQ6). Our final research question explored whether the differences in visual information processing impacted the learning outcomes (RQ7).

2. Method

2.1 Design

This research is a between-group experimental design. Participants were randomly assigned to one of the three conditions: neutral, authentic, or off-topic. The background of the video was the only difference between the conditions, and thus the independent variable. Participants' prior knowledge as well as their WMC were measured as potential control or

moderator variables. The eye-tracking and learning outcome measures were the dependent variables.

2.2 Participants

In order to obtain sufficient statistical power (ES = .80, α =.05), this research needed a minimum of 106 participants (Cohen, 1992). We were able to recruit 54 participants, but only maintained 47 (12 male and 35 female) for the analysis. The participants were students from a middle and high school situated in the south of the Netherlands. In the educational system in the Netherlands, starting from middle school, children are divided over different educational levels depending on their intellectual abilities. These are VMBO (pre-vocational secondary education), HAVO (senior general secondary education), and VWO (pre-university education). The participants were recruited on all three levels, 10 on VMBO, 20 on HAVO, and 17 on VWO. They were between 14 and 17 years old (M=15.57, *SD*=1.02). All participants spoke and understood Dutch on a native or near-native level, and had normal or otherwise corrected-to-normal vision. Students received a letter asking them to participate in the research. The 14 and 15-year-old students needed the approval of a parent or legal guardian in order to participate. The parents or legal guardians of 16 and 17 year-old-students only needed to be informed. Participation was on a voluntary basis. There was no advantage for students who participated, nor was there a disadvantage for students who did not participate. This research was ethically approved by The Research Ethics Committee of the Open University.

2.3 Instruments

2.3.1 Video

The instructional videos were made by recording a Zoom session in which a PowerPoint presentation was used as a virtual background. The biggest part of the PowerPoint slides was

green, with the actual image of the different slides that had be shown in the final video in the top corner. This created a green screen effect (see Figure 3), which made it possible to change the backgrounds so that there would be three videos which were identical except for the background. The video lasted 9 min and 37 s.

The topic of the video was glaciers. The instructor showed some examples of glaciers and of landscapes formed by them, she explained what a glacier is, discussed five typical aspects of glaciers, and finally talked about the uncertain future of glaciers. While explaining, she showed fifteen different slides containing either pictures, keywords or schematic images. Some of the slides had an animation, such as arrows that appeared in order to clarify the position of a typical formation for instance.

Figure 4

Image of a PowerPoint Slides and a Screenshot Showing the Same Slide as a Background in the Video

2.3.2 Working Memory Capacity Test

Working memory capacity as an individual difference variable, was measured through the Letter-Number Sequencing test. This is a subtest for the measurement of working memory and attention (Crowe, 2000) adapted from the Wechsler Adult Intelligence Scale IV. The participant listened to a pre-recorded set of letters and numbers (e.g., K-4-C-2-S) and then repeated these, but not in the same sequence as they were presented. The letters and numbers had to be placed in numerical and alphabetical order (e.g., 2-4-C-K-S). There were ten levels, each level contained three sequences. The amount of numbers and letters in a sequence gradually increased. Level one started with only two elements per sequence, in level ten there

were eight elements per sequence. The participant obtained one point for each correct sequence. The points were summed up to a total score with a minimum of 0 and a maximum of 30 points. See Appendix A for the complete test.

2.3.3 Eye Tracking Measures and Material

The eye tracking data used in this research, was based on the viewer's interaction with the background, the teacher, and the PowerPoint slides. Therefore, we created three areas of interest (AOI). The AOI's background and PowerPoint were static AOIs, they both did not change in shape or position. The *AOI background* was activated during the entire video, the *AOI PowerPoint* was only active if a PowerPoint slide was visible. The *AOI teacher* was a dynamic AOI which means that its shape an position were adapted to the teachers' movements. This AOI was also active during the entire video. Figure 5 shows the PowerPoint and teacher AOI's at different moments in the video.

To answer research questions 4 to 7 this master thesis used three different measurements. These measurements are based on fixations. A fixation is the event that occurs when the gaze stops and stays fixated for a while. It is considered to measure the attention the viewer pays to the area that is being fixated (Holmqvist et al., 2011). In the current research an event was defined a fixation, if it lasted for at least 60 ms (Tobii Pro Ab, 2014). Figure 6 gives an impression of the gaze path of one of the participants. The dots are the fixations.

The first measure was the *total time spent within each AOI*. This was the sum of the total duration in milliseconds of all fixations a viewer made within the AOI. The second measure was based on the count of the *total number of fixations within each AOI*. The third measure concerns the *rapidity with which a viewer directs the gaze toward the PowerPoint slides*. This measure was calculated by summing up the time in milliseconds to the first fixation within each slide. The participant with the lowest score is the participant who was the fastest.

The eye tracking data was recorded by a Tobii Pro Nano eyetracker. The video was presented on a HP ProBook 650 G2 (15,6” monitor, display resolution of 1366 x 768, set 60 to 80 cm in front of the participant) via Tobii Pro Lab version 1.162.32461 x64 software. The same software was used to analyze the eye tracking data. The audio was transferred through Tecknet headphones.

Figure 5

Two Video Stills, Showing the AOI PowerPoint Activated (on the Left) and Deactivated (on the Right), and a Change in the Shape of the AOI Teacher.

Figure 6

Example of a Gaze Path, Showing Fixations on the Teacher, Slides, and Background.

Note. Each Dot is a Fixation. The Larger the Dot, the Longer the Fixation Lasted.

2.3.4 Prior Knowledge Test

This master thesis measured prior knowledge as a covariate, since differences in prior knowledge might strongly affect the posttest results (Dochy et al., 2002). The prior knowledge was assessed through a paper-and-pencil test in Dutch. It consisted of nine glacier-related terms such as Lambert Fisher or firn. These same terms appeared again in the instruction video. Participants were asked to indicate whether they were familiar with the term and to briefly write down what they knew about it. There was a maximum score of 27 points that could be obtained. One point per familiar item and one or two extra points for the explanation.

The rating was based on a rubric containing keywords that should be mentioned in the explanation of the item. For instance, if a participant indicated that she or he was familiar with the term *Lambert Fisher*, this person obtained one point. If she or he mentioned that it is the *biggest glacier in the world* and that it is *situated in Antarctic*, this person obtained two extra points. If the participant only mentioned one of those aspects, then only one extra point was attributed. The first twenty tests were rated by two independent persons. Since the ICC score of .97 showed a good reliability (Koo & Li, 2016) the remaining tests were rated by one person. See Appendix B for the complete test and the grading rubric.

2.3.5 Posttest

The learning outcomes were also assessed through a paper and pencil test in Dutch. It consisted of 13 open-ended questions since these might be more sensitive to the differences between the instructional conditions (Mayer, 2010). There were 3 transfer questions and 10 retention questions. This research developed a grading rubric containing either the exact answers, or the key-words that needed to appear in the answers in order to obtain points. Participants could obtain a total of 22 points for the test. 14 points for the retention questions and 8 points for the transfer questions.

An example of a retention question is: *Indicate the location of the Lambert Fisher glacier and the Kutiah Lungma glacier.* The participant obtained half a point for each, if the answer was correct. An example of a transfer question is: *a glacier in Italy has been covered with white cloth, explain why this might have been done*. In order to obtain the maximum of three points the answer should contain the following words, or words similar to: *lack of snow, reflection, warming up.*

Again, the first twenty tests were rated by two independent persons. The ICC score for the total test, as well as for the retention questions, was .98. The ICC score for transfer questions was .97. Because of these high scores, the remaining tests were rated by one person. See Appendix C for the complete test and the grading rubric.

2.3.6 Subjective Rating Scales and Manipulation Check

To shed further light on the outcomes of this research, participants were asked to answer various statements concerning their learning experience. For this they could answer on a Likert scale form 1 *(not at all)* to 7 *(very much).* The statements were in Dutch and based on the questions asked in the Merkt et al. (2019) research. They concern distraction ("I found the background of the video to be very distracting"), difficulty ("The topic of the video was very difficult"), comprehension ("After watching the video I had a good understanding of different glacier formations"), quality of instruction ("The explanations given in the video were very clear"), and expertise of the instructor ("The teacher was very competent"). The last question is a manipulation check ("There was a good fit between the video and the background"). See Appendix D for an overview of these questions in Dutch.

2.4 Procedure

Participants were tested in individual sessions, which took about 50 minutes. First, there was a brief welcome during which the procedure was explained. The experimenter

verified if the informed consent was signed by the participant, and a parent if applicable. Furthermore, the experimenter reminded the participants that all collected date would be anonymized, that their participation was on a voluntary basis and that they were free to withdraw at any time. After this the participant answered a few demographic questions concerning age, sex, study year, and level. This was followed by the paper-and-pencil prior knowledge test. Once this was finished, the WMC was assessed. Participants put on the headphones and, after a sound check, the actual test started. The experimenter kept the score. Next, the participant received a brief explanation about the eye tracking procedure, if necessary, participants were asked to remove their eye make-up. If everything was in order the participant took place behind the screen. The experimenter made sure the distance between the screen and the participant was about 60-70 cm. Then the five-point calibration was started. Once this was validated the participant was friendly reminded not to move too much and she or he was invited to start watching the instructional video. After watching the video, the participant took the pencil-and-paper posttest in order to assess the learning outcomes. Finally the participant answered a few subjective questions about the learning experience. After this there was a debriefing, however participants were only informed about the exact research topic once all the data had been collected, since they all attended the same school.

2.5 Data Analysis

Initially this master thesis research collected data of 54 participants. After screening the eye tracking data, seven participants were excluded from the analyses. Five because of a gaze sample (i.e. ratio of eye movements tracked by the eye tracking device) below 90%. The sixth participant has severe difficulties making eye contact in real life. Inspection of the eye tracking data revealed that this participant experienced the same difficulties when watching the teacher in the video, resulting in a very high amount of time spent on the AOI Background

and hardly any time on the AOI Teacher. This impression was confirmed with outlier analyses on eye tracking data. The seventh participant was excluded because of a combination of findings. First of all, the outlier analyses revealed that this participant spent a very high amount of time on the background compared to the other participants in the same condition. Second, compared to the other participants, this person had one of the highest WMC scores (25 out of 30, the highest score obtained within this group was 27), but, the lowest score on the posttest (3 out of 22). Third, this participant already indicated during the experiment losing interest. Even though this could also occur in real life, especially in this age group, the decision was made to exclude the data, considering the relatively small participant group and the impact the extreme scores from this participant could therefore have on the outcomes of the analysis. Data was analyzed with IBM SPSS Statistics 26.

3. Results

Table 1 provides the descriptive statistics from the analyzed data. The overall score on prior knowledge was very low compared to the maximum score of 27 that could be obtained, furthermore there was no significant difference between groups; F (2, 44) = 1.11, p = .34, therefore prior knowledge was not included as a covariate in our analyses.

Because of a violation of normal distribution, the outcomes of the self-report measures were tested through a Kruskal-Wallis test. There was a statistically significant difference in the perceived distraction caused by the background across the three different background version groups, χ^2 (2, n = 47) = 6.84, p =.033. The off-topic background group recorded a significantly higher median sore (Md = 4) than the neutral group (Md = 3, p = .009). There was also a statistically significant difference in the perceived fittingness of the background across the three groups, χ^2 (2, n = 47) = 30.6, p < .001. The off-topic background group recorded a significantly lower median sore (Md = 1) than the authentic (Md = 3, p = .001) and neutral group (Md = 5, p < .001)). There were no statistically significant differences across the

Table 1

Means (M) and Standard Deviations (SDs) of the Measures per Condition

	Authentic (n=13)		Neutral (n=17)		Off-topic (n=17)		Total (n=47)	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Prior knowledge (max. =27)	2.69	1.32	2	1.06	2.41	1.46	2.34	1.29
Working memory capacity (max. =30)	20	1.73	20.35	1.77	20.35	3.52	20.26	2.49
Total posttest (max.=22)	10.89	2.97	10.18	2.26	9.32	3.86	10.06	3.11
Total retention (max.=14)	7.35	1.90	6.77	1.26	6.32	2.51	6.77	1.96
Total transfer (max.=8)	3.54	1.31	3.41	1.52	3	1.72	3.30	1.53
Total of first fixation time on AOI PowerPoint in s	205828.99	156.60	205839.54	278.39	205857.94	310.86	205843.28	259.05
Total time on AOI background in s	2562.18	1160.76	2205.59	1551.46	3192.54	2153.98	2661.20	1728.10
Number of fixations within AOI background	74.31	28.41	38	21.76	87.18	50.95	65.83	41.87
Total time on AOI PowerPoint in s	17417.88	3979.34	17916.47	2338.03	17930.97	3342.19	17783.80	3157.52
Number of fixations within AOI PowerPoint	347	77.76	360.59	51.81	358.82	85.60	356.19	71.37
Total time on AOI teacher in s	28734.35	3199.88	26831.32	3533.15	26475.52	5460.44	27229	4276.99
Number of fixations within AOI teacher	285.15	130.43	312.24	108.28	322.29	83.03	308.38	105.56
How distracting was the background*	3.46	1.13	2.82	1.24	4.12	1.65	3.47	1.46
How difficult was the topic*	3.15	1.28	3.53	1.50	3.59	1.62	3.45	1.47
Understanding of the topic*	4.62	1.80	4.35	1.66	4.59	1.33	4.51	1.56
How clear were the explanations*	4.92	0.86	4.82	1.13	4.82	1.70	4.85	1.29
How competent was the teacher*	4.46	1.56	4.59	1.46	3.94	1.68	4.32	1.56
How fitting was the background*	3.08	1.19	4.76	1.89	1.12	0.33	2.98	2.03

Note. * selfreport measures on likertscale 1-7

three groups regarding the other selfreport measures; difficulty of the topic, χ^2 (2, n = 47) = 0.92, p = .631, understanding of the topic , χ^2 (2, n = 47) = 0.16, p = .921, clear explanations, χ^2 (2, n = 47) = 0.17, p = .917, and competency of the teacher, χ^2 (2, n = 47) = 1,87, p = .392.

To investigate the effect of the video's background on the learning outcomes (RQ1), a one-way between-group analyses of variance was conducted for the total posttest score, followed by a one-way between-groups multivariate analysis of variance for the scores on retention and transfer. Even though there was a difference in the mean scores per version, both tests did not reveal a significant effect: F (2, 44) = .94, p = .4 for the Anova and F (4, 86) = .54, p = .70, Wilks' Λ = .95, partial $\eta 2$ = .03 for the Manova.

Next, the effect of the WMC on the learning outcomes (RQ2) was tested. Since the assumptions of normality and linearity were met, we used a one-tailed Pearson product-moment correlation coefficient. As expected there was a medium (Cohen, 1988) significant positive correlation between WMC and the total posttest results; r =.45, n = 47, p = .001, WMC and the retention questions; r = .39, n = 47, p = .003, and WMC and the transfer questions; r =.40, n = 47, p= .003.

We then conducted a one-way between-groups analysis of covariance in to investigate whether the background version had an effect on the learning outcomes if we controlled for WMC (RQ3a). In line with the previous findings, WMC was significantly related to the posttest results F (1, 43) = 12, p = .001, partial η^2 = .22. Still the background version had no significant effect on the posttest results F (2,43) = 1.5, p = .240, partial $\eta 2$ = .06.

To investigate whether WMC moderates the relationship between the video condition and the learning outcomes (RQ3b) a two-way between groups analysis of variance was conducted. We created three WMC groups; high, medium, and low. Participants who were able to recall and correctly reposition up to five items were placed in the medium group, those

who recalled less than five items in the low group, and over five items in the high group. As the descriptive statistics in table 2 show, there were few participants within the high and low WMC groups, therefore the results should be interpreted with caution.

Table 2

Means, Standard Deviations and Number of Participants, Concerning Posttest Results per WMC Level

WMC	Authentic			Neutral			Off-topic			Total		
	M	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*	*N*	*M*	*SD*	*N*
low	13	3.13	3	9.67	2.02	3	6.75	3.8	4	9.50	3.92	10
medium	9.93	3.25	7	9.91	2.15	11	8.36	2.9	7	9.48	2.67	25
high	11.89	1.32	3	11.67	3.06	3	12.17	3.6	6	11.75	2.86	12

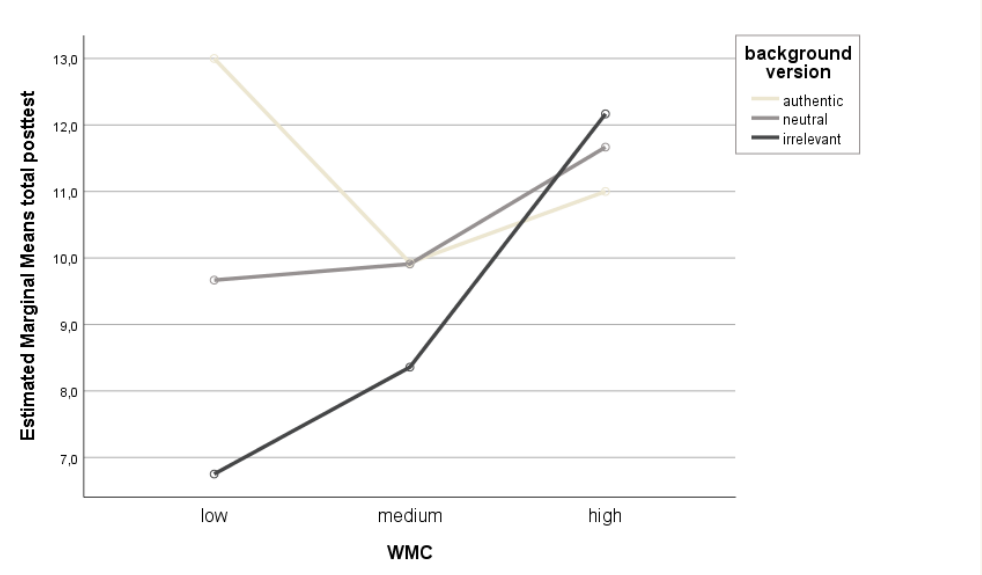
We then continued with the preliminary analysis. A boxplot inspection showed there were no outliers and Shapira-Wilk's test ($p > .05$) confirmed that the data was normally distributed. Furthermore, there was homogeneity of variances, as assessed by Levene's test for equality of variances, $p = .343$. Next we conducted the two-way Anova. Although figure 7 seems to show a disordinal interaction effect between background version and WMC, this was not statistically significant F (4, 38) = 1.624, $p = .188$, partial $\eta^2 = .146$, nor were the main effects of the background version, F (2, 38) = 2.025, $p = .146$, partial $\eta^2 = .096$ and WMC, F (2, 38) = 2.220, $p = .122$, partial $\eta^2 = .105$.

The analyses were continued by exploring the effect of the video's background on the leaner's visual information processing (RQ4) through a one-way multivariate analyses of variance. The dependent variables were: rapidity of the first fixation on the AOI PowerPoint, the total time spent on each one of the three AOI's (background, PowerPoint, teacher), and the number of fixations within each AOI. The independent variable was the background-version. The preliminary assumption testing for normality, linearity, univariate and multivariate outliers, homogeneity of variance-covariance matrices, and multicollinearity, did

not reveal any serious violations. There was a statistically significant difference between the three different backgrounds F (14, 78) = 2.52, p = .005, Pillai's Trace = .62, partial η2 = .31. The number of fixations on the neutral background (M = 38, SD = 21.76) was significantly lower than the number of fixations on the authentic background (M = 74.31, SD = 28.41) and the off-topic background (M = 87.18, SD = 50.95), F (2, 44) = 8.18, p = .001, partial η2 = .27.

Figure 7

Means of Learning Outcomes per Version and WMC Level



Next, we tested the effect of the WMC on the learner's visual information processing (RQ5). We used a Pearson product-moment correlation coefficient in order to investigate the influence of the WMC on the total time spent on the AOI's PowerPoint and Teacher, as well as on the total number of fixations on both those AOI's (RQ5a). The preliminary analyses showed a violation of the assumptions of normality and linearity concerning the Rapidity (RQ5b) and AOI Background measurements (RQ5a). Therefore, a Spearman's rank-order correlation coefficient was used for those variables. The results showed a medium (Cohen, 1988) negative correlation between WMC and the number of fixations within the PowerPoint slides, r = -.30, n = 47, p = .04, and a medium (Cohen, 1988) positive correlation between WMC and the time spent on the AOI Teacher, r = .38, n = 47, p = .008. Table 3 and 4 show the complete results of the correlation tests.

Table 3

Pearson Correlation on Influence of WMC on Time Spent and Number of Fixations on AOI's

Variable	1	2	3	4	5
1. WMC	-				
2. total time on AOI PowerPoint	-.29	-			
3. number of fixations within AOI PowerPoint	-.30*	.25	-		
4. total time on AOI teacher	.38**	-.67**	-.60**	-	
5. number of fixations within AOI Teacher	.03	-.47**	.24	.12	-

Note. *p < .05. **p <.01. two-tailed

Table 4

Spearman Correlation on Influence of WMC on Time Spent and Number of Fixations on AOI's

Variable	1	2	3	4
1. WMC	-			
2. total of first fixation time on AOI PowerPoint	.20	-		
3. total time on AOI background	-.10	-.47**	-	
4. number of fixations within AOI background	-.10	-.26	.79**	-

Note. Regarding the total of the first fixation time measure; a low score is fast, a high score is slow
*p < .05. **p <.01. two-tailed

We then tested the effect of the video's background on the learner's visual information processing while controlling for WMC (RQ6). We conducted a one-way between-groups multivariate analyses of covariance. While testing the preliminary assumptions, a visual inspection of scatterplots revealed that some pairs of dependent variables were not linearly related, as were some of the relationships between the covariate and dependent variables, the decision was made to run the analysis, accepting that this might result in a loss of power. There was homogeneity of regression slopes, as assessed by the interaction term between background version and WMC, F (14, 70) = .531, p = .906, and there was homogeneity of variances and covariances, as assessed by Box's M test, p = .033. The standardized residuals showed one univariate outlier in the data (SD 3.23) on the rapidity measurement. There were

no multivariate outliers in the data, as assessed by Mahalanobis distance, ($p > .001$). Shapiro-Wilk's test showed that the assumption of normality was violated on the rapidity measure ($p = .023$) and on the time spent on the PowerPoint slides in the off-topic version ($p = .042$).

There was a statistically significant difference between the different background version on the combined dependent variables after controlling for WMC, F (14, 74) = 2.87, $p = .002$, Wilks' $\Lambda = .42$, partial $\eta 2 = .352$. Table 5 shows the descriptive statistics. Follow up univariate one-way ANCOVAs were performed. A Bonferroni adjustment was made such that statistical significance was accepted when $p < .007$. There was a statistically significant difference in the adjusted mean for the number of fixations on the background F (2, 43) = 8.332, $p = .001$, partial $\eta 2 = .279$, but not for the other visual information processing measurements. The statistics are displayed in table 6.

Bonferroni post hoc test showed that the number of fixations on the background was statistically significantly lower in the neutral background group ($M_{adj} = 38.32$, SE = 8.73) compared to the authentic background ($M_{adj} = 73.47$, SE = 10), a mean difference of 35.15, 95% CI [2.05, 68.25], $p < .034$, and compared to the off-topic background ($M_{adj} = 87.5$, SE = 8,73), a mean difference of 49.18, 95% CI [18.41, 79.42], $p < .001$.

Finally we tested if the visual information processing had an effect on the test results (RQ7). Again, a Pearson product-moment correlation coefficient was performed in order to investigate this, except for the data concerning the Rapidity and AOI Background for which we used a Spearman's rank-order correlation coefficient. Visual information processing had no significant effect on the learning outcomes (table 7 and 8).

Table 5

Means (M), Adjusted Means (M_{adj}), standard deviations (SD) and Standard Errors (SE) for the visual information processing measures for each of the three video background conditions

		Authentic	Neutral	Off-topic
Total of first fixation time on AOI PowerPoint in s	*M (SD)*	205828.99 (156.60)	205839.54 (278.39)	205857.94 (310.86)
	M_{adj} *(SE)*	205834.68 (72.63)	205837.36 (63.43)	205855.77 (63.43)
Total time on AOI background in s	*M (SD)*	2562.18 (1160.76)	2205.59 (1551.46)	3192.54 (2153.98)
	M_{adj} *(SE)*	2518.21 (464.98)	2222.41 (406.12)	3209.35 (406.12)
Number of fixations within AOI background	*M (SD)*	74.31 (28.41)	38 (21.76)	87.18 (50.95)
	M_{adj} *(SE)*	73.47 (10)	38.32 (8.73)	87.50 (8.73)
Total time on AOI PowerPoint in s	*M (SD)*	17417.88 (3979.34)	17916.47 (2338.03)	17930.97 (3342.19)
	M_{adj} *(SE)*	17323.03 (865.03)	17952.73 (755.54)	17967.24 (755.54)
Number of fixations within AOI PowerPoint	*M (SD)*	347 (77.76)	360.59 (51.81)	358.82 (85.60)
	M_{adj} *(SE)*	344.73 (19.42)	361.46 (16.96)	359.69 (16.96)
Total time on AOI teacher in s	*M (SD)*	28734.35 (3199.88)	26831.32 (3533.15)	26475.52 (5460.44)
	M_{adj} *(SE)*	28908.47 (1094.54)	26764.75 (955.99)	26408.95 (955.99)
Number of fixations within AOI teacher	*M (SD)*	285.15 (130.43)	312.24 (108.28)	322.29 (83.03)
	M_{adj} *(SE)*	285.39 (30)	312.14 (26.21)	322.20 (26.21)

Table 6

One-Way ANCOVA Statistics for Visual Information Processing Measurements

	F	Sig.	Partial η^2
Total of first fixation time on AOI PowerPoint in s	0.031	.970	.001
Total time on AOI background in s	1.543	.225	.067
Number of fixations within AOI background	8.332	.001*	.279
Total time on AOI PowerPoint in s	.196	.823	.009
Number of fixations within AOI PowerPoint	.243	.785	.011
Total time on AOI teacher in s	1.660	.202	.072
Number of fixations within AOI teacher	.442	.646	.020

*Note. df 2, 43; *p <.007*

Table 7

Pearson correlation on influence of visual information processing on learning outcomes

	total time on AOI PowerPoint	number of fixations within AOI PowerPoint	total time on AOI teacher	number of fixations within AOI Teacher
1. total posttest	-18	.03	.25	-.5
p two-tailed	*.24*	*.84*	*.09*	*.77*
2. retention	-.2	.01	.25	-.00
p two-tailed	*.18*	*.94*	*.09*	*.1*
3. transfer	-.1	.05	.19	-.92
p two-tailed	*.50*	*.75*	*.2*	*.54*

Table 8

Spearman correlation on influence of visual information processing on learning outcomes

	total of first fixation time on AOI PowerPoint	total time on AOI background	number of fixations within AOI background
1. total posttest	0	-.15	-.11
p two-tailed	*.95*	*.3*	*.45*
2. retention	.08	-16	-.13
p two-tailed	*.58*	*.28*	*.4*
3. transfer	-.13	-.07	-.04
p two-tailed	*.40*	*.62*	*.77*

4. Discussion

The primary goal of this study was to investigate the effects of a video's background on learning. We compared three conditions; an authentic background, which could have a positive impact on learning since it might be a sign of expertise, a neutral background, which could lead to better learning results because of the lack of potentially distracting seductive details, and an off-topic background which contained seductive details and lacked any sign of expertise, therefore being the background that would negatively impact learning the most, provided that the background had any impact.

The different backgrounds did not lead to a statistically significant difference in learning outcomes (RQ1), nor did the differences in visual information processing (RQ7). Taking WMC into consideration, did not alter these findings (RQ3a, RQ3b). Nevertheless the mean score on the posttest was lower for the viewers who watched the off-topic version of the video (RQ1c) compared to those who watched the other two versions (RQ1a, RQ1b).

Furthermore, the choice of the background did have a statistically significant impact on the viewers' visual information processing (RQ4), even if we controlled for WMC (RQ6). Viewers paid more attention to the authentic, and the off-topic background. Hence we can conclude that the background of an instructional video does attract the learners' visual attention. According to the expert hypothesis, this could be positive in the authentic condition, but there was no evidence found indicating that looking at the authentic background stimulated learning, although viewers did not indicate it was distracting either. The off-topic background on the other hand, was considered to be distracting. The neutral background attracted the least attention, allowing viewers to focus on the teacher and the slides. Spending less time on the background decreased the time it took viewers to look at the PowerPoint slides.

Regarding the impact of differences in WMC on learning outcomes and visual information processing in combination with the different background versions, we were able to confirm a positive correlation between WMC and learning outcomes (RQ2). Furthermore we found that, regardless of the background, a higher WMC resulted in a lower number of fixations within the PowerPoint slides (RQ5b). This could indicate that the viewers with lower WMC experienced search difficulties (Ehmke & Wilson, 2007), which would be in line with the findings that a higher cognitive load increases the time needed before fixations land on relevant information (Fabio et al., 2015) and induces a higher amount of re-fixations (Cain & Mitroff, 2013). This seems to confirm the idea that a higher WMC leads to a more effective visual search performance (Brunyé et al., 2019). An inspection of the scanpaths confirmed that the fixations of the viewers with a higher WMC were more accurate. For instance, if the teacher spoke about a specific kind of glacier crack which is formed in a particular area of the glacier, viewers with a higher WMC almost immediately looked at that part of the glacier whereas viewers with lower WMC scanned the entire schematic representation.

We did not find that the viewers with a higher WMC needed less time to look at the PowerPoint slide once it appeared (RQ5a). This is probably due to the fact that this research labeled the entire PowerPoint slide, and all PowerPoint slides, as relevant. Considering the above mentioned findings regarding the fixations, it is very well possible that a rapid first fixation hit on a PowerPoint slide was not necessarily a fixation on a relevant (part of the) slide. Also, the difference in visual information processing between viewers with a higher WMC and those with a lower WMC shows similarities with the differences in visual information processing between experts and novices. Experts are able to discard irrelevant information more easily (Jarodzka et al., 2010). If this also applies to viewers with higher WMC then this could mean they did not pay as much attention to slides they considered less

relevant, resulting in the significantly higher amount of time they spent focused on the teacher.

4.1 Limitations of This Study and Suggestions for Future Research

The labelling of all PowerPoint slides and the entire slides as relevant, is one of the limitations of this research. For future research it would be preferable to conduct a pilot study up front, in order to identify which slides and which areas within the slides are considered relevant to viewers with a higher WMC. Another limitation is the lack of statistical power due to the limited number of participants (Cohen, 1992), since this induces the risk of a type II error (Field, 2013).

Other limitations and suggestions for further research concern the teacher, the type of knowledge, the students, the learning environment, the duration, and finally, the backgrounds. Regarding the teacher it would be useful to investigate whether findings are similar under comparable circumstances but with different teachers, since, as previously mentioned, the way the viewer experiences the teacher's expertise, has an impact on learning outcomes (Hoogerheide et al., 2016; Lachener & Nückles, 2015; Boekhout et al., 2010).

Furthermore it would be interesting to investigate whether the findings are similar if the explanations in the video concern procedural knowledge instead of theoretical knowledge (Hong & Yang, 2016). The rapidity with which a relevant fixation is made, for instance, might matter more in such a procedural knowledge scenario.

Regarding students' characteristics, this master thesis measured WMC through the Letter-Number Sequencing test, which is based on auditory input, but this could also be measured through other instruments, such as a visual arrays task (Martin et al., 2021) which is based on visual input. Also, unlike Merkt et al. (2019), we did not measure other specificities such as the participants' interest in the topic, or their motivation, even though these can impact learning (e.g., Krapp, 1999).

Concerning the learning environment, Choi et al. (2014) suggest that the physical environment in which learning takes place could have an effect on the experienced cognitive load. This research was conducted in a small office. The only two persons present were the researcher and the participant. There were no distractions. In reality learners are likely to watch instructional video's in a potentially more distraction environment such as a classroom, or their own living rooms or bedrooms. Since this might increase the experienced cognitive load, further research would be needed to investigate whether this amplifies the effects of a video's background and WMC.

The current research found that the different backgrounds had an impact on the visual information processing but not on learning outcomes. Participants only watched one video, and were tested immediately afterwards. Further research is needed to investigate whether the visual information processing does affect learning outcomes if the learning material consist of multiple videos, presented over a longer period of time, or if the learning outcomes are measured at a later time.

The last limitation and suggestion concerns the choice of the backgrounds. It would be interesting to investigate whether the off-topic background as a whole was distracting, or only certain features in the image. For instance, research has shown that peoples gaze is drawn towards faces (e.g. Langton et al., 2008; Thoma & Lavie, 2013) and there was a women present in the picture used as off-topic background. Our findings might have been different if there was no human present in the off-topic background.

4.2 Conclusions

Even though further research is still needed, this master thesis tends to confirm the distraction hypothesis. Educators should be aware that their choice for a background in an instructional video, and possibly also during an online course, has an effect on their students' information processing. It is important that educators are aware of the fact that a distracting

background affects students with a lower WMC more than those with a higher WMC. Because of their visual information processing, persons with higher WMC are not as easily overloaded compared to persons with a lower WMC, giving them a double advantage, the in itself higher capacity and the lower load that needs to be processed. A distracting background could therefore amplify existing differences between students.

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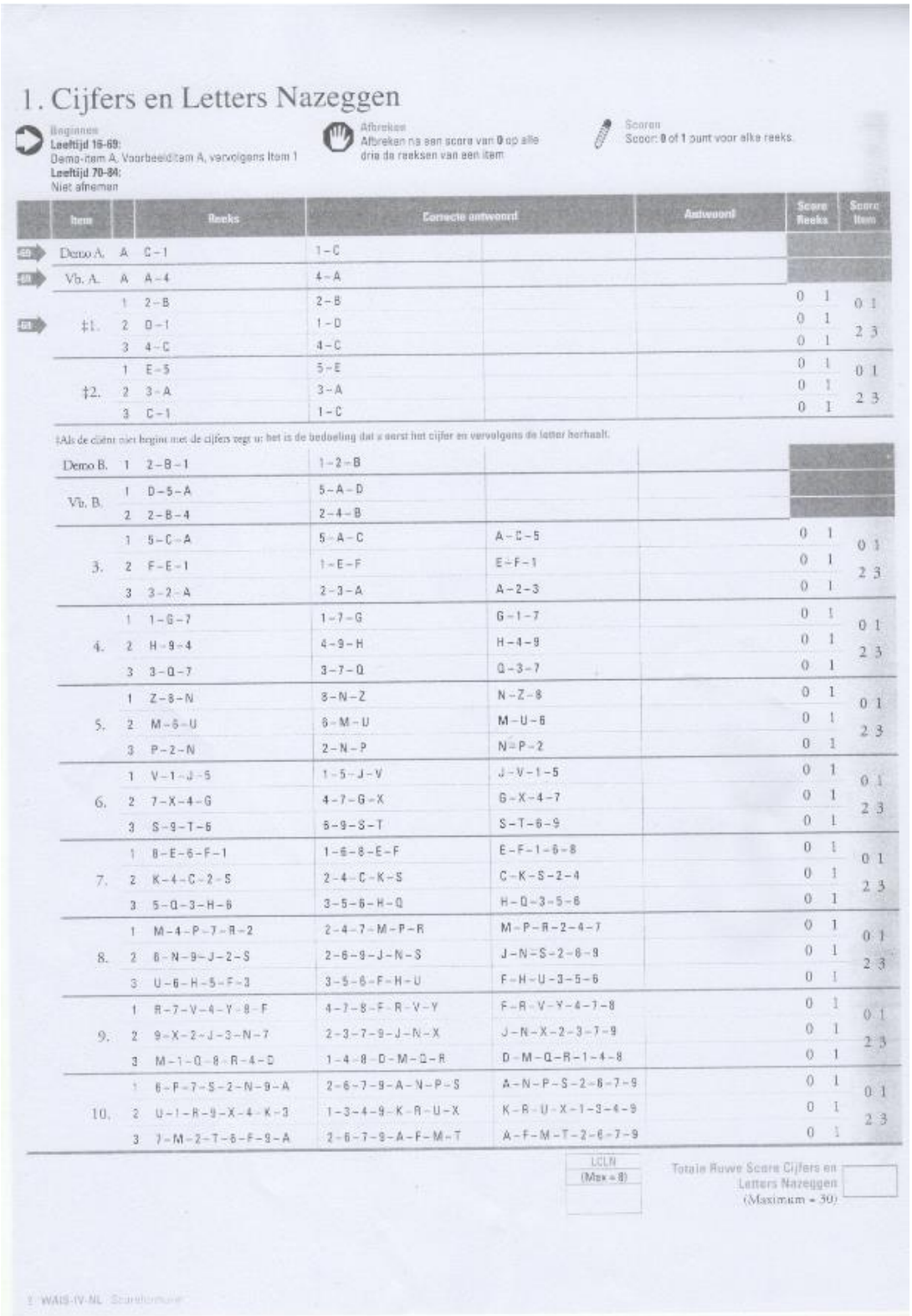
Appendix A Letter-Number Sequencing Test From WAIS IV



1. Cijfers en Letters Nazeggen

Beginnen
Leeftijd 16-69:
Demo-item A. Voorbeeld item A, vervolgens Item 1
Leeftijd 70-84:
Niet afnemen

Afbreken
Afbreken na een score van **0** op alle drie de reeksen van een item

Scoren
Scoor: **0** of **1** punt voor alke reeks.

	Item		Reeks	Correcte antwoord		Antwoord	Score Reeks	Score Item
GO	Demo A.	A	C-1	1-C				
GO	Vb. A.	A	A-4	4-A				
		1	2-B	2-B			0 1	0 1
GO	‡1.	2	D-1	1-D			0 1	2 3
		3	4-C	4-C			0 1	
		1	E-5	5-E			0 1	0 1
	‡2.	2	3-A	3-A			0 1	2 3
		3	C-1	1-C			0 1	

‡Als de cliënt niet begint met de cijfers zegt u: het is de bedoeling dat u eerst het cijfer en vervolgens de letter herhaalt.

Demo B.	1	2-B-1	1-2-B			
Vb. B.	1	D-5-A	5-A-D			
	2	2-B-4	2-4-B			
	1	5-C-A	5-A-C	A-C-5	0 1	0 1
3.	2	F-E-1	1-E-F	E-F-1	0 1	2 3
	3	3-2-A	2-3-A	A-2-3	0 1	
	1	1-G-7	1-7-G	G-1-7	0 1	0 1
4.	2	H-9-4	4-9-H	H-4-9	0 1	2 3
	3	3-Q-7	3-7-Q	Q-3-7	0 1	
	1	Z-8-N	8-N-Z	N-Z-8	0 1	0 1
5.	2	M-6-U	6-M-U	M-U-6	0 1	2 3
	3	P-2-N	2-N-P	N-P-2	0 1	
	1	V-1-J-5	1-5-J-V	J-V-1-5	0 1	0 1
6.	2	7-X-4-G	4-7-G-X	G-X-4-7	0 1	2 3
	3	S-9-T-6	6-9-S-T	S-T-6-9	0 1	
	1	B-E-6-F-1	1-6-B-E-F	E-F-1-6-B	0 1	0 1
7.	2	K-4-C-2-S	2-4-C-K-S	C-K-S-2-4	0 1	2 3
	3	5-Q-3-H-6	3-5-6-H-Q	H-Q-3-5-6	0 1	
	1	M-4-P-7-R-2	2-4-7-M-P-R	M-P-R-2-4-7	0 1	0 1
8.	2	6-N-9-J-2-S	2-6-9-J-N-S	J-N-S-2-6-9	0 1	2 3
	3	U-6-H-5-F-3	3-5-6-F-H-U	F-H-U-3-5-6	0 1	
	1	R-7-V-4-Y-B-F	4-7-B-F-R-V-Y	F-R-V-Y-4-7-B	0 1	0 1
9.	2	9-X-2-J-3-N-7	2-3-7-9-J-N-X	J-N-X-2-3-7-9	0 1	2 3
	3	M-1-Q-8-R-4-D	1-4-8-D-M-Q-R	D-M-Q-R-1-4-8	0 1	
	1	6-P-7-S-2-N-9-A	2-6-7-9-A-N-P-S	A-N-P-S-2-6-7-9	0 1	0 1
10.	2	U-1-R-9-X-4-K-3	1-3-4-9-K-R-U-X	K-R-U-X-1-3-4-9	0 1	2 3
	3	J-M-2-T-8-F-9-A	2-8-7-9-A-F-M-T	A-F-M-T-2-8-7-9	0 1	

LCLN (Max = 8)

Totale Ruwe Score Cijfers en Letters Nazeggen (Maximum = 30)

1 WAIS-IV-NL Scoreformulier

Appendix B Prior Knowledge Test and Rubric

Pré-toets

Je gaat zo dadelijk een filmpje over gletsjers bekijken. Na het kijken van het filmpje maak een kennistoetsje. We willen graag weten hoeveel je geleerd hebt van het filmpje en hoeveel je vooraf al wist. Daarom vragen we je om eerst de onderstaande vraag te beantwoorden:

Hieronder staan een aantal termen en namen die iets met gletsjers te maken hebben. Zet een kruisje voor de termen en namen die je bekend voorkomen en schrijf kort op wat je weet.

	Lambert Fisher	
	Kutiah Lungma	
	Firn	
	Spleten	
	Bergschrund	
	ijsvallen	
	Seracs	
	Morenen	
	Niet-Aper	

****

Beoordeling

Score 0-27

Per onderdeel 0 – 3 punten te behalen; term bekend = 1 punt; uitwerking: 1 element genoemd=1 punt; 2 of meer elementen=2 punten

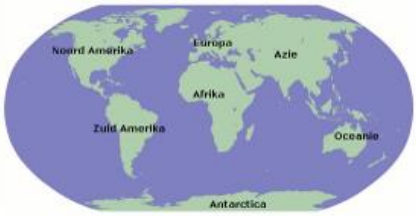
Rubric

	Lambert Fisher	• Grootste ter wereld • Antartica
	Kutiah Lungma	• Snelste groei • Pakistan
	Firn	• ijskorrels (uit sneeuwkristallen) • middelste laag
	Spleten	• breuken in (gletsjer)ijs • ontstaan door beweging (en/of bochten)
	Bergschrund	• (gletsjerspleet) op hoger deel • ontstaat waar de gletsjer van de rots breekt
	ijsvallen	• soort waterval van ijs • ontstaat waar gletsjer smaller of steiler stroomt
	Seracs	• instabiele blokken ijs (gevaarlijk) • ontstaan bij ijsvallen
	Morenen	• gletsjerpuin • aan einde (of zijkant) van gletsjer
	Niet-aper	• plek op de gletsjer met sneeuw • gevaarlijker dan apere plekken

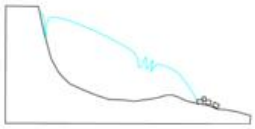
Appendix C Posttest and Rubric

Deze toets bestaat uit 13 vragen

1. Hieronder zie je een afbeelding van de wereldkaart. Zet een kruisje (**X**) op de plek waar de **Kutiah Lungma** gletsjer ligt. Zet een cirkel (**O**) op de plek waar de **Lambert Fisher Glacier** ligt.

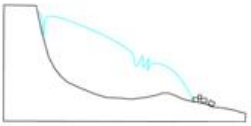


2. Wat is bijzonder aan de Kutiah Lungma gletsjer?
3. Wat is bijzonder aan de Lambert Fisher Glacier?
4. Leg kort uit hoe gletsjers ontstaan. Gebruik het woord "**firn**" in je uitleg.
5. Noem twee voorbeelden van landschapsveranderingen die ontstaan zijn door gletsjers.
6. Je ziet hier een dwarsdoorsnede van een gletsjer. Geef met een pijl aan waar de "**spleten**" te zien zijn.



1

7. Hoe ontstaan spleten?
8. Geef met een pijl aan waar de "bergschrund" te vinden is op de onderstaande dwarsdoorsnede.



9. Hoe ontstaat de "bergschrund"?
10. Leg uit waarom het afgeraden wordt om alleen, of zonder touw en reddingsmateriaal op een niet-apere gletsjer te lopen.
11. Je ziet hier 4 foto's. Welke foto hoort bij welke term. Je houdt één term over. Zet de letter van de foto achter de bijbehorende term.

morenen _____ bergschrund _____
spleten _____ serac _____
ijsval _____


A

B

C

D

2

12. Op de onderstaande foto zie hoe een gletsjer in Italië wordt ingepakt met witte doeken. De tweede foto is een close-up van het doek. Waarom zou dit gedaan worden? Geef uitgebreid antwoord.

13. Uit "De Volkskrant" 19 juni 2019:
Zo'n 1,6 miljard mensen in landen als India, Pakistan en China zijn geheel of gedeeltelijk afhankelijk van water uit de Himalaya voor irrigatie (landbouw), waterkracht en drinkwater.
Wat is het verband tussen dit stukje tekst en gletsjers? Welke problemen kunnen in de toekomst ontstaan?

3

Rubric (Let op: Niet voor deelnemer!!)

1. *Retention*
*2x 0.5= **1 point***

2. *Retention*
*Snelste/grootste groei **1 point** (in 3 mnd tijd 12 km groei=**0.5 punt**)*

3. *Retention*
*Grootste ter wereld **1 point** (400 km lang & 100 breed=**0.5 punt**)*

4. *Retention*
- *Accumulatie sneeuw (door seizoenen heen)*
- *Sneeuw die niet gesmolten is wordt in de winter bedekt door nieuwe sneeuw*
- *Sneeuwkristallen worden firn*
- *Firn wordt gletsjerijs*

3-4 genoemd= 3 punten, 2 genoemd= 2 punten, 1 genoemd=1 punt

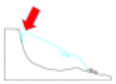
5. *Retention*
*-fjorden (in Noorwegen) = **0.5***
*-(spitse) bergtoppen (in de Alpen) = **0.5***
Total: 1 point

6. *Retention (because shown exactly like this in powerpoint)*
1 point

4

7. Retention
Door de druk op op het ijs (door de steile hellingshoek -> druk door sneeuw o.i.d. is fout) (en/of) door de bewegingen die de gletsjer maakt (en/of) doordat de gletsjer tegen een andere gletsjer op botst
1 point

8. *Retention (because shown exactly like this in powerpoint)*
1 point



9. Retention

Doordat de gletsjer (het ijs) van de rots afbreekt = ***1 point*** *(als het woord ijs gebruikt wordt, moet rots of berg er bij, niet gewoon afbrekend ijs) dit komt door:*

door de afstromende beweging van het ijs = ***+0.5*** *(alleen beweging is fout, moet duidelijk zijn naar het naar beneden gaat)*

door de hogere temperatuur van de rots in de zomer = **+0.5** (rots of berg moet erbij, alleen hogere temperatuur of veranderende temperatuur is fout)

total 2 points

10. Retention
Omdat spleten verborgen kunnen liggen onder sneeuw(bruggen (gaten o.i.d. is ook goed, maar er moet wel benoemd worden dat er een sneeuwbrug is of dat er een "lege ruimte" onder de sneeuw kan liggen) ***1 point***
Sneeuwbruggen zijn niet altijd sterk genoeg om het gewicht van een persoon te houden (je kunt er doorheen zakken o.i.d. is ook goed) ***1 point***
Total 2 points

11. *Transfer (because not the same pictures as in the powerpoint presentation)*
4 x 0.5
Total 2 points

morenen	__B____	bergschrund	__D____
spleten	_____	seracs	__A____
ijsval	__C____		

12. *Transfer*

Noem : niet genoeg/geen nieuwe sneeuw, reflectie, smelten (woordkeuze hoeft niet per se hetzelfde te zijn)

Voorbeeld: er is niet genoeg nieuwe sneeuw, sneeuw reflecteert normaal gesproken het zonlicht, de witte doeken hebben hetzelfde effect waardoor de gletsjers minder snel opwarmen en minder snel smelten

Total 3 points (1 point per aspect, if used correctly)

13. *Transfer*

Benoem 3 van de volgende aspecten : waterhuishouding, drinkwater, smeltwater, overstromingen, droogte (woordkeuze hoeft niet per se hetzelfde te zijn)

Voorbeeld: Het smeltwater van de gletsjers voorziet de bevolking van (drink)water. Het snelle smelten van de gletsjers kan problemen in de waterhuishouding veroorzaken, door te veel smeltwater ontstaan er overstromingen, als de gletsjers uiteindelijk verdwijning krijgen de landen juist last van droogte (waardoor er problemen ontstaan voor de landbouw, elektriciteits- en drinkwatervoorzieningen)

Total 3 points (1 point per aspect, if used correctly)

****

Totaal: 22 points
Retention: 14
Transfer: 8

Appendix D Subjective Rating Scales and Manipulation Check in Dutch

Hieronder staan een paar stellingen. Geef aan in hoeverre je het met de stelling eens bent.

1 = volledig oneens
7 = volledig eens

1. De achtergrond van de video leidde me erg af. 1 – 2 – 3 – 4 – 5 – 6 – 7
2. Het onderwerp van de video was heel moeilijk. 1 – 2 – 3 – 4 – 5 – 6 – 7
3. Na het kijken van de video begreep ik goed hoe verschillende gletsjerformaties (zoals spleten) ontstaan. 1 – 2 – 3 – 4 – 5 – 6 – 7
4. De uitleg in de video was heel duidelijk. 1 – 2 – 3 – 4 – 5 – 6 – 7
5. De docent was heel deskundig. 1 – 2 – 3 – 4 – 5 – 6 – 7
6. De achtergrond paste goed bij de video. 1 – 2 – 3 – 4 – 5 – 6 – 7