MASTER'S THESIS

Instructor Presence in a Virtual Learning Environment in Dutch Primary School Students:

An Investigation into Embodiment and Social Cues, Exploring Differences in Social Presence, Cognitive Load, Motivation, and Learning Outcomes

Pielage, Fenny

Award date:
2024

Awarding institution:
Faculty of Educational Sciences

Open Universiteit

Instructor Presence in a Virtual Learning Environment in Dutch Primary School Students: An Investigation into Embodiment and Social Cues, Exploring Differences in Social Presence, Cognitive Load, Motivation, and Learning Outcomes

Leerkracht Aanwezigheid in een Virtuele Leeromgeving bij Nederlandse Basisschoolleerlingen: Een Onderzoek naar Presentie en Gebaren, een Verkenning van Verschillen in Sociale Aanwezigheid, Cognitieve Verwerking, Motivatie en Leerprestaties

Fenny Pielage

Master Onderwijswetenschappen, Open Universiteit

E-mailadres: fennypielage@gmail.com

Cursuscode en cursusnaam: OM9906 Masterscriptie

Naam begeleider: dr. Kate Xu

Woordenaantal: 7770

Datum: 14 juni 2024

Abstract

Corona-virus pandemic has had major effects on students in different educational domains. Approximately 1.6 billion students were out of school worldwide. The importance of preparedness has become evident for educational institutions to offer online education. Social presence has been hypothesised to play an important role in facilitating learning in online learning environments. Instructor presence can enhance students' perceived social presence. Instructor presence and the use of social cues can reduce cognitive load by promoting sufficient available cognitive resources for learning. Also, instructor presence can positively influence students' motivation and learning performance. Most studies examining instructor presence are conducted with higher education students. This experimental study addresses the need for more research that involves primary school students and is based on a quantitative between subjects design. The purpose was to evaluate instructor presence during an online lesson in 138 Dutch primary school students in grade 7 and 8. Participants were randomly divided into three conditions with the platform CloudClass: a control condition with text, images, and the teacher's narrative; an experimental condition with a teacher as a static image; and an experimental condition with a teacher expressing social cues. The results of the analysis of covariance show no statistically significant differences between the three conditions on the outcome measures social presence (social presence questionnaire), cognitive load (Cognitive Load Index), motivation (Intrinsic Motivation Inventory), and learning outcomes (knowledge test), but did not show any negative effects either.

Keywords: virtual learning environment, instructor presence, social presence, cognitive load, motivation

Samenvatting

De coronaviruspandemie heeft tot grote gevolgen geleid binnen verschillende onderwijsdomeinen. Wereldwijd sloten onderwijsinstellingen de deuren voor ongeveer 1,6 miljard studenten. Het belang werd aangetoond dat onderwijsinstellingen paraat staan online onderwijs te bieden. Sociale aanwezigheid wordt verondersteld een belangrijke rol te spelen in het faciliteren van leren in online leeromgevingen. Leerkrachtaanwezigheid kan de waargenomen sociale aanwezigheid van studenten verbeteren. Leerkrachtaanwezigheid en het gebruik van sociale signalen kunnen cognitieve belasting verminderen, door de beschikbaarheid van voldoende cognitief vermogen voor leren te bevorderen. Daarnaast kan leerkrachtaanwezigheid de motivatie en leerresultaten van studenten positief beïnvloeden. De meeste studies naar leerkrachtaanwezigheid zijn uitgevoerd met studenten in het hoger onderwijs. Deze studie vervult een behoefte aan onderzoek onder basisschoolleerlingen. Deze experimentele studie is gebaseerd op een kwantitatief between subjects design. Het doel was leerkrachtaanwezigheid te evalueren tijdens een online les aan 138 Nederlandse basisschoolleerlingen uit groep 7 en 8. De deelnemers werden random toegewezen aan een van de drie condities met het platform CloudClass: een controle conditie met tekst, afbeeldingen en instructie door de leerkracht; een experimentele conditie met een leerkracht als statisch beeld; en een experimentele conditie met een leerkracht die sociale signalen gebruikt. De resultaten van de covariantieanalyse laten geen statistisch significante verschillen zien tussen de drie condities op de uitkomstmaten sociale aanwezigheid (social presence questionnaire), cognitieve belasting (Cognitive Load Index), motivatie (Intrinsic Motivation Inventory) en leerresultaten (knowledge test), maar laten ook geen negatieve effecten zien.

Keywords: virtual learning environment, instructor presence, social presence, cognitive load, motivation

Content

Instructor Presence in a Virtual Learning Environment in Dutch Primary School Students: An Investigation into Embodiment and Social Cues, Exploring Differences in Social Presence, Cognitive Load, Motivation, and Learning Outcomes

1. Introduction

1.1 Problem Statement and Purpose

Coronavirus-pandemic has been impacting face-to-face education and made teachers abruptly shift to online education. More than 180 countries temporarily closed schools, with approximately 1.6 billion students out of school at its peak in early April 2020 (Azevedo et al, 2021). The effect on students after two years of pandemic is clearly noticeable, as they have difficulty concentrating and finding motivation to learn (Inspectie van het Onderwijs, 2022). Moreover, in the Netherlands, a decrease in student performance was found on a national exam of 0.08 *SD*, as well as a decrease in mathematics performance of 0.29 *SD* (Azevedo et al., 2021). Schools underestimated the importance of connectedness and social presence. Students cannot focus on learning, unless they have their basic need of connection met by teachers being present, either face-to-face or online (Ensmann et al., 2021).

In face-to-face education teachers are physically and emotionally present, while in online education teachers offer instruction typically through virtual classes or record instruction for students to watch later (Chisadza et al., 2021). Although in many cases online education tries to create a feeling of teachers being physically and emotionally present, the feeling is not the same, resulting in less involvement and motivation (Meeter et al., 2020). Virtual learning environments differ from other online learning environments in their similarity to real life (Yilmaz et al., 2013). Online learning instructional techniques can simulate that feeling of teachers being physically and emotionally present but are currently not implemented in everyday learning and instruction (Delgado et al., 2020). For example,

online instructor presence may increase students' sense of social presence when teachers support their needs (Zilka et al., 2018), and facilitate the use of previously acquired knowledge to minimize the limits of working memory during learning (Yu, 2021). Instructor presence also promotes students' motivation and significantly improves their performance (Colliot & Jamet, 2018; Yu, 2021). Students tend to learn more deeply when an on-screen teacher displays humanlike gesturing, movement, eye contact, and facial expressions (Mayer, 2014). Research is needed to better understand instructor presence in facilitating learning effectively in virtual learning environments (Henderson & Schroeder, 2021). Most of the studies examining instructor presence are conducted with higher education students and participants in the United States (Alemdag, 2022). This study addresses the need for more research that involves primary school students.

With multiple media opportunities, platforms may help increase students' perception of instructor presence by diversifying interaction (Yilmaz & Keser, 2017). The interactivity of a platform has been found to be positively associated with perceived instructor presence (Park & Kim, 2020). This study is part of the Open University project "CloudClass: Low Cost, Mobile, Cloud & Template Based Augmented Reality Studio for Education", that explores the effectiveness of CloudClass (2023) implementations. CloudClass is an online studio, where teachers can create three-dimensional (3D) virtual learning environments. During coronavirus-lockdown, primary schools generally used platforms that show the teacher on-screen in a rectangular representation.

The purpose of this study is to evaluate different forms of instructor presence, expressed in embodiment and social cues, during an online lesson in Dutch primary school students. Social presence, cognitive load, motivation, and learning outcomes are measured within three conditions. The platform CloudClass is used to explore this purpose. The results

of this study may help educational institutions understand how instructor presence is effective within a platform.

1.2 Theoretical Framework

1.2.1 Instructor Presence in a Virtual Learning Environment

Instructor presence signifies all forms of an on-screen instructor who is present in a virtual learning environment. Instructor presence reflects the important communication for educating, aiding, and leading cognitive and social processes (Zilka et al., 2018). When teachers are present during online learning activities, students have a greater sense of instructor presence (Jaggars et al., 2013; Park & Kim, 2020). According to Baker (2010), when teachers are seen on screen, they can be identified as present in a virtual learning environment. In virtual learning environments, students can perceive a social relationship with the teacher, which may play an important role during their learning process (Mayer, 2014; Moreno, 2005). For example, teachers can be a social role model or a mentor (Mayer, 2014; Moreno et al., 2001). The embodiment principle shows that students' social responses are stimulated and students learn and process more deeply when teachers in virtual learning environments display high embodiment (i.e., embodiment through social cues: humanlike gesturing, movement, eye contact, and facial expressions), compared to low embodiment (i.e., embodiment without social cues: a static image or a talking head) (Dunsworth & Atkinson, 2007; Mayer, 2014; Moreno et al., 2010).

1.2.2 Instructor Presence and Social Presence

Social presence entails the feeling of belonging to a community (Nagel & Kotzé, 2010). In virtual learning environments, where embodiment through social cues is being used, instructor presence promotes social presence (Colliot & Jamet, 2018; Henderson & Schroeder, 2021). With respect to the original social presence theory (Short et al., 1976), Kreijns et al. (2022) reformulated a conceptualizable definition of social presence in virtual learning

environments, namely: “The psychological phenomenon in which, to a certain extent, the other persons are perceived as physical ‘real’ persons in technology-mediated communication enabled by computer-mediated communication tools and electronic platforms” (p. 141). Social presence, in this case, is the illusion of being together, as if the communication is not facilitated by virtual media (Kreijns et al., 2022).

Social presence is an important construct in education, as it is significantly related to motivation and learning outcomes (Robb & Sutton, 2014; Weaver & Albion, 2005). The educational context determines the effectiveness of social presence in a virtual learning environment (Henderson & Schroeder, 2021). Teachers are responsible for establishing and maintaining social presence in a virtual learning environment, which makes instructor presence required for social presence to occur (Garrison et al., 2009). The role of an online instructor therefore demands skills in facilitating communication (Garrison et al., 2000). Strong student-instructor interactions are achieved by using interactive communication tools that promote students’ perceptions of instructor presence (Park & Kim, 2020). Instructor’s immediacy behaviours through embodiment and social cues, such as humour, social sharing, and greetings, provide social presence and student satisfaction with the instructor (Mayer, 2014; Richardson, 2001).

Ng and Przybyłek (2021) investigated the effect of instructor presence on perceived social presence in a randomized online between-subjects experiment with 95 university students in Poland. Participants watched a 10-minute educational video in either a condition with or without instructor presence. Afterwards, participants self-reported social presence. Results surprisingly showed that participants in the condition without instructor presence reported slightly higher social presence. This may be due to an unacceptably low Cronbach’s α (0.24) for the social presence scale in this condition. In the condition with instructor presence Cronbach’s α is 0.70, which is in line with previous research (Ng & Przybyłek,

2021). Furthermore, research by Lyons et al. (2012) with 158 university students in the United States shows that social presence is a dynamic subjective construct that is affected by personal attributes (e.g., technological efficacy), interacting with video lecture attributes (e.g., presence/absence of social cues).

1.2.3 Instructor Presence and Cognitive Load

Instructor presence in a virtual learning environment, by means of embodiment of the teacher and the use of social cues, can stimulate cognitive processing, assist information retention, and knowledge transfer. This reduces cognitive load (Henderson & Schroeder, 2021). In the context of online education, students should be affected to get involved in tasks and processes that support the construction of knowledge and cognitive schemas (Costley, 2019; Mayer, 2014). Cognitive psychology assumes that human cognitive structure consists of a long-term memory and a working memory. While long-term memory is limitless, working memory is limited in both holding capacity and duration. Instruction that exceeds working memory capacity will be ineffective (Sweller, 2004). However, these limits decline when dealing with previously acquired knowledge organized in cognitive schemas in long-term memory (Choi et al., 2014). Cognitive load refers to the amount of working memory resources used by instructional materials in the context of students' prior knowledge (Kalyuga & Plass, 2018). Reducing cognitive load to leave sufficient cognitive resources for the actual learning to take place, is one of the main guidelines of cognitive load theory (Skulmowski & Xu, 2022). This study takes into account three distinct types of cognitive load, according to cognitive load theory: 1) intrinsic load, determined by task complexity and prior knowledge, 2) extraneous load, determined by instructional features unfavourably for learning, and 3) germane load, determined by instructional features beneficially for learning (Leppink et al., 2013).

Choi et al. (2014) argue that instructor presence can affect cognitive load by adding unnecessary information or increasing difficulty. Instructor presence can cause divided attention between the learning material and the teacher being present (Mayer, 2021). Non-task messages by teachers may distract students from the main learning topic (Schroeder et al., 2017). Recommendable design choices may therefore be under the condition that learners are not continually being overloaded (Skulmowski & Xu, 2022). Instructor presence may increase cognitive load (Colliot & Jamet, 2018), but instructor presence can also stimulate cognitive processing, aid information retention, and transfer knowledge (Henderson & Schroeder, 2021). Embodied instruction theory for example recommends teachers' movements and gestures to support the processing of information (Price et al., 2016). According to the embodiment principle, social cues provided by teachers are also important for students to be able to follow the instruction (Mayer, 2021).

Wang et al. (2020) conducted a study with 60 university students in the United States. Participants either watched an instructional video with or without an instructor present. While watching the video, the spontaneous electrical activity of all participants' brains was measured using electroencephalography (EEG). After watching the video, participants also self-reported the cognitive load they experienced. Findings based on the EEG-data show decreased cognitive load with an instructor present. A lower level of cognitive load is also self-perceived by participants in the condition with an instructor present compared to participants in the condition without an instructor present (Wang et al., 2020). Instructor presence may therefore help decrease cognitive load linked with processing the video. Social cues of the teacher could help students focus on aspects of the learning material and concentrate on processing the information more easily, which lowers cognitive load (Wang et al., 2020). Research has been inconsistent in the literature regarding the effect of instructor presence on cognitive load. Although instructor presence may increase cognitive load by

adding unnecessary information to the learning material, research also shows that instructor presence aids decreasing cognitive load, for example, through the use of social cues. More research is needed to further clarify this issue.

1.2.4 Instructor Presence and Motivation

Instructor presence is known to positively influence students' motivation (Baker, 2010; Henderson & Schroeder, 2021). Social presence and satisfaction in virtual learning environments correlate positively. Hence, social presence promoted through teachers' embodiment and social cues can be associated with enhanced student motivational factors (Richardson et al., 2017). Students may develop a social relationship with the teacher, which results in positive feelings and motivation. This social relationship can also help increase students' value for learning and decrease pressure (Kim et al., 2007; Kim & Baylor, 2016).

Motivation is an inner process that encourages students to behave in a certain way, gives direction to that behaviour, and ensures that this behaviour is maintained (Schuit et al., 2011). Perceptions of teachers being present create a positively motivated learning climate (Zhao & Li, 2016). The Self Determination Theory (SDT; Ryan & Deci, 2000) distinguishes between intrinsic motivation (i.e., doing a task because it is inherently interesting), extrinsic motivation (i.e., doing a task with either resentment or willingness, because it leads to a separable consequence); and amotivation (i.e., lacking an intention to do a task) (Ryan & Deci, 2000). Intrinsic motivation is an important construct in education, as it can be systematically catalysed or undermined by teacher practices (Ryan & Stiller, 1991). In this study the emphasis is on intrinsic motivation, because of its natural tendency, and it being a critical element for students to acquire knowledge (Ryan & Deci, 2000).

Geographical distance can lead to poor connections between instructor and student. Online courses are therefore regarded as lacking instructor presence, which is known to increase student intrinsic motivation (Colliot & Jamet, 2018). However, students who report

higher levels of interaction with teachers in virtual learning environments, report higher levels of intrinsic motivation (Swan, 2001). Teachers are part of the virtual learning environment and influence student motivation through affective experiences of working together (Linnenbrink-Garcia et al., 2010).

Wang and Antonenko (2017) researched instructor presence and its effect on motivation in an experiment with 36 university students in the United States, using two conditions with/without instructor presence and difficult/easy learning material. Participants were randomly assigned to a condition with or without instructor presence and viewed both the difficult and easy instructional video. Overall, instructor presence was found to have a significantly positive effect on participants' perceived learning and satisfaction, which are seen as essential factors that influence student intrinsic motivation (Wang & Antonenko, 2017). Roque-Hernández et al. (2021) collected data from 1.417 Mexican university students to research instructor presence and motivation, using a survey method. Their research was conducted during the coronavirus-lockdown, with participants who would normally have been studying in-person. Participants rated their experiences based on their perceptions of instructor presence during online classes. The results show that student awareness of their teachers in an online course positively affects students' motivation.

1.2.5 Instructor Presence and Learning Outcomes

Instructor presence is the most important predictor of students' learning performance (Jaggars et al., 2013). Instructor presence influences learning interaction between teacher and student, which has a direct influence on learning outcomes (Wei et al., 2012). Virtual learning environments are regarded as lacking instructor presence because of the poor connections between instructor and student (Colliot & Jamet, 2018). However, when students perceive strong instructor presence through the expression of social cues, they will engage in learning

interactions, resulting in enhanced learning outcomes in online courses (Bolliger, 2004; Henderson & Schroeder, 2021).

1.2.6 Instructor Presence and Platform

Platforms' interactive software features, such as video conferencing, and chats, are crucial in the development of instructor presence in virtual learning environments. These features facilitate contact between teachers and students, and make students feel supported through instructor presence (Roque-Hernández et al., 2021). Nevertheless, educational institutions have expressed concerns about instructor presence within virtual learning environments, because of limited knowledge regarding the usability of different platforms (Roque-Hernández et al., 2021). Platforms might have the appearance to be neutral information transmitters or facilitators of interactions, but they intercede in what they make visible and in what they make users able to do (Decuypere et al., 2021). Although there is little existing empirical evidence of the educational value and performative effects of virtual reality (VR) based learning environments, students seem to report higher levels of instructor presence in these learning environments, compared to other more traditional online learning environments (Makransky et al., 2019; Robertson, 2019).

Van Dijck and Poell (2018) define a platform as: "a programmable digital architecture designed to organize interactions between users" (p. 4). The platform used in this study to evaluate instructor presence through embodiment and social cues is CloudClass. This plug and play solution runs in the cloud, on a laptop, PC, or mobile phone, and does not require expensive and specialized equipment. In CloudClass teachers can create augmented reality (AR) and VR learning environments and present this to learners.

According to Park and Kim (2020), the level of interactivity of communication tools in virtual learning is positively associated with perceptions of instructor presence. CloudClass could give teachers the opportunity to take advantage of this finding in adopting a

technological tool to create videos, give homework and instant feedback, encourage students to interact frequently, and leave messages visible to all students. With the advancement of technology, CloudClass' new technology may meet students' needs in online learning and enhance instructor presence even further (Bettinger & Loeb, 2017).

1.2.7 Prior Knowledge as a Covariate

As a subject characteristic, prior knowledge is an influential factor of perceived cognitive load (Chen et al., 2017; Paas et al., 1994). Additionally, different levels of prior knowledge will lead to different levels of learning outcomes (Chen et al., 2017; Baek et al., 2015). Prior knowledge is also associated with motivation, as it provides a feeling of competence (Schiefele et al., 2012). To reduce unexplained variance in these outcome variables and to increase statistical power (Kahan et al., 2014), prior knowledge is included in this study as a covariate.

1.2.8 Limitations in Previous Research

Research into instructor presence in virtual learning environments lacks primary school students as a research population. Primary school students are generally habituated to face-to-face education and may therefore be overlooked. However, coronavirus-pandemic has shown the importance of good quality online education for primary school students, as they experience difficulties concentrating, reduction in motivation (Inspectie van het Onderwijs, 2022), and declines in learning outcomes (Azevedo et al., 2021) after the pandemic. Parents also observed a decline in motivation and connectedness in their primary school-aged child, related to the pandemic (Bakx et al., 2020). This study therefore aims to contribute to knowledge about the needs of primary school students within virtual learning environments, from students' perspective.

1.3 Research Questions and Hypotheses

Complementary research is needed that involves primary school students, to further understand how instructor presence is effective for their learning in a virtual learning environment. The purpose of this study is to evaluate different forms of instructor presence, expressed in embodiment and social cues, during an online lesson in Dutch primary school students. Social presence, cognitive load, motivation, and learning outcomes are measured within three conditions, namely: (1) control condition, CloudClass with text and images, but only the voice of the teacher, (2) experimental condition 1, CloudClass with text and images, the voice of the teacher, and embodiment of the teacher through a static image of half the body, (3) experimental condition 2, CloudClass with text and images, the voice of the teacher, and embodiment of the teacher through half the body, including the expression of social cues. To realise the purpose of this study, the following research question is answered:

How does instructor presence in a virtual learning environment affect the learning process in Dutch primary school students through embodiment and social cues?

Hypothesis 1: There is a significant difference in perceived social presence between the three conditions. Experimental conditions 1 and 2 score significantly higher than the control condition. Experimental condition 2 scores significantly higher than experimental condition 1.

Hypothesis 2: There is a significant difference in perceived cognitive load between the three conditions. Experimental conditions 1 and 2 score significantly lower than the control condition. Experimental condition 2 scores significantly lower than condition 1.

Hypothesis 3: There is a significant difference in perceived motivation between the three conditions. Experimental conditions 1 and 2 score significantly higher than the control condition. Experimental condition 2 scores significantly higher than condition 1.

Hypothesis 4: There is a significant difference in achieved learning outcomes between the three conditions. Experimental conditions 1 and 2 score significantly higher than the control condition. Experimental condition 2 scores significantly higher than condition 1.
Hypothesis 5: There is a significant difference in perceived social presence, cognitive load and motivation, and achieved learning outcomes in all conditions when participants have a higher level of prior knowledge.

2. Method

2.1 Design

More insight was gained into instructor presence through embodiment and social cues with a quantitative between subjects experimental design (Creswell, 2014). The research was executed within existing classes. As part of an existing research line within a project, this study was approved by the ethics committee cETO of the Open University. The ethical approval was registered under number U202304707. The platform CloudClass was used to modify a learning environment to determine differences on social presence, cognitive load, motivation, and learning outcomes. Participants were randomly assigned to one of three conditions. The conditions consisted respectively of a control condition in which participants underwent an intervention through CloudClass, with text and images, and the voice of the teacher, and two experimental conditions, in which participants underwent an intervention through CloudClass with text and images, the voice of the teacher, and the teacher being present on-screen. In the first experimental condition, half the body of the teacher was shown as a static image that did not express social cues. In the second experimental condition, half the body of the teacher was shown that did express social cues. In all conditions, prior knowledge was pre-measured with a knowledge test, to minimize unexplained variance and to increase statistical power (Kahan et al., 2014). Three dependent variables were post-measured

with questionnaires: social presence, cognitive load, motivation. One dependent variable was post-measured with a knowledge test: learning outcomes.

2.2 Participants

This study has been carried out with Dutch students, aged 9 to 13 years old (M = 10.79, SD = 0.72), in grade 7 and 8 of two primary schools in a metropolitan region in the Netherlands. The size of the study population was 138 participants (70 girls and 68 boys), divided into six classes. A power calculation was executed with G*Power (Faul et al., 2007), using an F-test. The calculation was based on a global effects multivariate analysis of covariance (MANCOVA). Outcomes indicated that the aim for this study was a minimum of 126 participants. The power calculation was based on a p-value of $\alpha = 0.05$ (Field, 2018), an effect size of $f^2 = 0.0625$, and a power level of $1 - \beta = 0.80$. The number of groups was set at three and the number of response variables at four.

2.3 Materials and Measurement Instruments

2.3.1 Materials: Instructional Videos

Pre-recorded lessons were used, providing an instruction about probability calculations in Dutch language (Gorter, 2021; Hoogerheide et al., 2014). The lessons had the same instructional message in all conditions and used ten slides. The instruction contained two examples of probability calculations, that explained step by step the required method for solving probability calculations. The first explanation used an example without replacement. The second explanation used an example with replacement (Gorter, 2021).

The instructional videos were recorded in the CloudClass studio of the Open University in the Netherlands. The videos had a duration of approximately nine minutes and were recorded with a neutral background and the same teacher for the conditions in question. The video in the control condition showed slides and the teacher's narration. The videos in the experimental conditions also included the teacher in front of the slides. During the

experiment, the instructional videos were accessible via a link to Vimeo (2023). When participants had watched the lesson, they could choose to either watch the video again or to immediately fill in the questionnaires and complete the knowledge test. The instructional script is enclosed in Appendix A. Images of what the conditions looked like are enclosed in Appendix B.

2.3.2 Measurement Instruments

2.3.2.1 Social Presence

Social presence was measured using five adapted items (Gorter, 2021) from a scale measuring social presence (Kreijns et al., 2018). An example item was 'In the video of the probability calculation lesson, it feels like the instructor is in the same room'. Gorter (2021) examined the reliability of the questionnaire and found it to be reliable, Cronbach's $\alpha = 0.94$. Responses were scored on a 10-point Likert scale ranging from 1 (completely true) to 10 (not at all true). The outcome measure was operationalized as the average score on the five items, varying between 1 and 10. The scale was translated in Dutch language and adapted to children of primary school age (Gorter, 2021). All items were inverted, wherefore a low outcome measure indicated a low level of perceived social presence and a high outcome measure a high level of perceived social presence. The entire questionnaire is included in Appendix C.

2.3.2.2 Cognitive Load

Cognitive load was measured with Cognitive Load Index (CLI; Leppink et al., 2013). CLI divides cognitive load into intrinsic load (IL), extraneous load (EL), and germane load (GL). Gorter (2021) found the reliability of fitting scales satisfactory, IL-scale Cronbach's $\alpha = 0.92$, EL-scale Cronbach's $\alpha = 0.80$, and ML-scale Cronbach's $\alpha = 0.88$. The questionnaire included ten items, an example item was 'I perceived the probability calculation video as very complex'. Responses were scored on a 10-point Likert scale ranging from 0 (not at all the case) to 10 (completely the case). The outcome measure was operationalized as the average

overall score and the average score per subscale, varying between 1 and 10. The scale was translated in Dutch language and adapted to children of primary school age (Gorter, 2021). The GL-scale items (e.g., items 7, 8, 9, and 10) were inverted, wherefore a low outcome measure indicated a low level of perceived cognitive load and a high outcome measure a high level of perceived cognitive load on all three subscales. The entire questionnaire is included in Appendix D. Two additional CLI-items on a 9-point Likert scale were included to increase the reliability of the scales, one item that measured overall cognitive load (CL) and one IL-item. The additional CL-item and IL-item were found to reduce reliability of the scale, whereby these items were eventually omitted. The two additional items are part of Appendix D.

2.3.2.3 Motivation

Motivation was measured on the basis of interest and enjoyment, using Intrinsic Motivation Inventory (IMI; Ryan & Deci, 2000). The interest/enjoyment items were used to measure intrinsic motivation in the performance of an activity (Ryan & Deci, 2000). The questionnaire included seven items, an example item was ‘I really enjoyed the probability calculation video’. Responses were scored on a 10-point Likert scale ranging from 1 (does not suit me at all) to 10 (totally suits me). The scale was obtained from a Dutch IMI-questionnaire via Vernieuwenderwijs.nl and was translated by Wessel Peeters (2018). The outcome measure was operationalized as the average score on the seven items, varying between 1 and 10. Item 5 was inverted, wherefore a low outcome measure indicated a low level of perceived motivation and a high outcome measure a high level of perceived motivation. McAuley et al. (1989) examined the validity of the questionnaire and found it to be reliable, Cronbach's $\alpha = 0.78$. Van Gool (2022) examined the validity of the translated version and found it also to be reliable, Cronbach's $\alpha = 0.89$. The entire questionnaire is included in Appendix E.

2.3.2.4 Learning Outcomes

Learning outcomes were measured with a knowledge test, consisting of eight items, that tested whether participants had learned to solve probability calculations (Gorter, 2021). Gorter (2021) considered the validity of the items reliable, Cronbach's α = 0.88. The test was in Dutch language and is included in Appendix F. Participants could score two points for each item. One point for the correct answer (e.g., $\frac{1}{5}$) and one point for using the correct method (e.g., $\frac{1}{5}$ x $\frac{1}{5}$ =). The outcome measure was operationalized as the total score on the eight items, varying between 0 and 16. A low outcome measure indicated a low level of learning outcomes and a high outcome measure a high level of learning outcomes.

2.3.2.5 Prior Knowledge

Prior knowledge was measured with a knowledge test, consisting of four items, that tested whether participants had prior knowledge about solving probability calculations (Gorter, 2021). The test is in Dutch language and is included in Appendix G. Participants could score two points for each item. One point for the correct answer (e.g., $\frac{1}{5}$) and one point for using the correct method (e.g., $\frac{1}{5}$ x $\frac{1}{5}$ =). The outcome measure was operationalized as the total score on the four items, varying between 0 and 8. A low outcome measure indicated a low level of prior knowledge and a high outcome measure a high level of prior knowledge. Gorter (2021) considered the validity of the items reliable, Cronbach's α = .89.

2.4 Procedure

The boards of two Dutch primary schools were approached personally and asked to participate in the study. Then the teachers of grades 7 and 8 were asked to participate in the study. Parents/guardians received an active informed consent letter (Creswell, 2014) from the teachers, in which permission was asked for the students of the six classes of grades 7 and 8 to participate in the study. If no permission was given, students were not included. After

permission from the boards, teachers, and parents/guardians was obtained, the study started with a try-out of all materials on four randomly selected students from grade 7 and 8. With the teachers, the course of the study and the needed materials (i.e., Chromebooks and earphones) was discussed.

Envelopes have been put together that included all measurement instruments and a pencil. The forms contained a link to one of the three conditions, equally divided over the number of participants per class. The experiment was executed in participants' habitual classroom, where they randomly received an envelope. Starting the experiment, participants first took a knowledge test of four assignments to test their prior knowledge about probability calculations. Next, participants entered the indicated link on their Chromebook, to watch an instruction of nine minutes in one of the three conditions within the platform CloudClass. Then, participants filled in three questionnaires that measured social presence, cognitive load, and motivation. Thereafter, participants took another knowledge test with eight assignments to test learning outcomes. Finally, all forms were collected, and participants were thanked for their participation by allowing them to keep the included pencil. The experiment lasted one hour per class. The results of the study were shared with the boards of the participating schools. Parents/guardians could receive an update of the study through the teachers.

2.5 Data Analysis

All data from the questionnaires and assignments were entered into IBM SPSS version 26. The data were screened for outliers, missing values, and normality, using descriptive statistics. Incomplete responses were coded as missing data. The reliability of the questionnaires was analysed, where a limit value of Cronbach's $\alpha = 0.70$ was applied (Cortina, 1993). These gave acceptable to good internal consistencies, social presence scale: Cronbach's $\alpha = 0.80$, CLI: IL-scale Cronbach's $\alpha = 0.88$, EL-scale Cronbach's $\alpha = 0.75$, and GL-scale Cronbach's $\alpha = 0.80$, and IMI: Cronbach's $\alpha = 0.94$.

Prior knowledge was included as a covariate at a continuous level (i.e., grades 0-16). There was one categorical predictor (i.e., independent variable), with three levels. The predictor was applied using different participants (i.e., between groups). The variance was explained by the predictor (i.e., instructor presence). Dependent variables were presented at a continuous level (i.e., social presence, cognitive load, and motivation: Likert-scale; learning outcomes: grades 0-16).

A one-way MANCOVA was used to answer the research question and hypotheses. The *F*-value was calculated to compare differences between the conditions. The *p*-value is $\alpha = 0.05$ and the effect sizes were shown in partial η^2. Levene's test was used to test homogeneity of variances. Additionally, a correlation analysis was done to determine connections between the dependent variables and assess whether the research population was representative.

3. Results

3.1 Participants

The participants were divided into three conditions. The control condition consisted of 44 participants with an average age of 10.77 (*SD* = 0.68), the experimental condition 1 consisted of 46 participants with an average age of 10.85 (*SD* = 0.67), and the experimental condition 2 consisted of 48 participants with an average age of 10.79 (*SD* = 0.81). Table 1 shows characteristics of the participants.

Table 1

Participants characteristics.

	Control condition	Experimental condition 1	Experimental condition 2
Grade 7 (#)	21	21	21
Grade 8 (#)	23	25	27
Boy (#)	23	23	22

	Control condition	Experimental condition 1	Experimental condition 2
Girl (#)	21	23	26
Other (#)	0	0	0

3.2 Assumptions

No extreme values or outliers were observed. The regression coefficients were equal in all conditions. The covariate explained 0.2% of the variance in the three conditions. In all conditions, the covariate prior knowledge was lower at the pre-test ($M = 0.29$, $SD = 0.68$) than learning outcomes at the post-test ($M = 6.22$, $SD = 4.97$). Variances were homogeneous for the dependent variables, Levene's test was not significant. Although Bartlett's test was significant and covariance matrices were not equal, causing the assumption of sphericity not being met, there was no significant difference in prior knowledge between the three conditions F (2, 135) = 0.15, $p = 0.86$.

3.3 Differences Between the Conditions

The results of the MANCOVA show that there were no overall statistically significant differences between the three conditions after receiving an instruction either without a teacher being present onscreen, a teacher shown as a static representation, or a teacher that expressed social cues F (14, 220) = 0.64, $p = 0.83$, Wilk's $\Lambda = 0.92$, partial $\eta^2 = 0.04$. Table 2 shows M and SD of the dependent variables in the three conditions, and the subdivision of cognitive load into intrinsic load, extraneous load, and germane load. Furthermore, the results show that there were no statistically significant differences between the conditions in social presence F (2, 116) = 0.35, $p = 0.70$, partial $\eta^2 = 0.01$. Also, there were no statistically significant differences in cognitive load F (2, 116) = 0.62, $p = 0.54$, partial $\eta^2 = 0.01$, subdivided into intrinsic load F (2, 116) = 0.37, $p = 0.70$, partial $\eta^2 = 0.01$, extraneous load F (2, 116) = 1.32, $p = 0.27$, partial $\eta^2 = 0.02$, and germane load F (2, 116) = 0.05, $p = 0.96$, partial $\eta^2 = 0.01$.

Similarly, no statistically significant differences were found in motivation F (2, 116) = 0.29, p = 0.75, partial η^2 = 0.01, or in learning outcomes F (2, 116) = 1.60, p = 0.21, partial η^2 = 0.03. The covariate prior knowledge was equally in all three conditions, but was slightly higher in experimental condition 2. Table 2 also shows *M* and *SD* of the covariate in the three conditions.

Table 2

Mean values (*M*) and standard deviations (*SD*) of the dependent variables and covariate in all conditions.

	Control condition		Experimental condition 1		Experimental condition 2	
	M	*SD*	*M*	*SD*	*M*	*SD*
Social Presence	5.03	2.29	5.23	2.43	5.47	2.36
Cognitive Load	4.91	1.54	5.29	1.36	4.92	1.81
Intrinsic Load	4.92	2.45	5.45	2.65	5.20	2.65
Extraneous Load	4.16	1.99	4.75	2.24	3.97	2.23
Germane Load	5.49	2.42	5.58	2.09	5.40	2.26
Motivation	5.90	2.52	5.54	2.73	5.95	2.26
Learning Outcomes	7.53	5.27	6.13	5.07	5.84	4.71
Prior Knowledge	0.27	0.09	0.26	0.09	0.33	0.12

Note. Dependent variables social presence, cognitive load, motivation, and learning outcomes. Covariate prior knowledge. Cognitive load is subdivided into intrinsic load, extraneous load, and germane load.

Correlations were identified between the dependent variables social presence, cognitive load, motivation, and learning outcomes. There was a significant correlation between social presence and learning outcomes r (137) = -0.19, p = 0.03, indicating that when social presence decreases, learning outcomes increase. There was also a significant correlation between cognitive load and learning outcomes r (134) = -0.36, $p < 0.00$, indicating that when cognitive load decreases, learning outcomes increase. A significant correlation between

cognitive load and motivation r (121) = -0.41, $p < 0.00$ indicates that when cognitive load decreases, motivation increases. Finally, a significant correlation between motivation and learning outcomes r (122) = 0.19, $p = 0.04$ indicates that when motivation increases, learning outcomes increase. Table 3 provides all outcomes of the correlation analyses.

Tabel 3

Correlations between dependent variables.

		Social Presence	Cognitive Load	*Intrinsic Load*	*Extraneous Load*	*Germane Load*	Motivation	Learning Outcomes
Social Presence	Pearson's *r*	1	-0.003	0.058	-0.037	-0.044	0.032	-0.186*
	Sig. (two-tailed)		0.977	0.506	0.675	0.623	0.727	0.030
	N	137	133	133	132	129	121	137
Cognitive Load	Pearson's *r*		1	0.777**	0.651**	0.651**	-0.410**	-0.355**
	Sig. (two-tailed)			0.000	0.000	0.000	.000	.000
	N		134	134	133	130	121	134
Intrinsic Load	Pearson's *r*			1	0.470**	0.178*	-0.270**	-0.332**
	Sig. (two-tailed)				.000	0.043	0.003	0.000
	N			134	133	130	121	134
Extraneous Load	Pearson's *r*				1	.0045	-0.238**	-0.350**
	Sig. (two-tailed)					0.609	0.009	0.000
	N				133	130	121	133
Germane Load	Pearson's *r*					1	-0.335**	-0.086
	Sig. (two-tailed)						0.000	0.332
	N					130	121	130
Motivation	Pearson's *r*						1	0.187*
	Sig. (two-tailed)							0.039
	N						122	122
Learning Outcomes	Pearson's *r*							1
	Sig. (two-tailed)							
	N							138

Note. * Correlation is significant at the 0.05 level (two-tailed).

** Correlation is significant at the 0.01 level (two-tailed).

4. Discussion

The purpose of this study was to evaluate different forms of instructor presence during an online lesson in Dutch primary school students, and distinguishing differences between three conditions in social presence, cognitive load, motivation, and learning outcomes. The platform CloudClass was used to explore this purpose. To answer the research question "How does instructor presence in a virtual learning environment affect the learning process in Dutch primary school students through embodiment and social cues?" a MANCOVA was executed. The results showed that different forms of instructor presence did not affect the learning process in Dutch primary school students. According to the drawn-up hypotheses, statistically significant differences were expected between the three conditions in social presence, cognitive load, motivation, and learning outcomes. A teacher who displays high embodiment, as employed in experimental condition 2, was expected to be most favourable for learning in a virtual learning environment (Dunsworth & Atkinson, 2007; Mayer, 2014; Moreno et al., 2010).

Results from previous research show that instructor presence is a crucial factor in facilitating social presence (Garrison et al., 2009; Mayer, 2014; Richardson, 2001), and that teachers are responsible for social presence to occur within virtual learning environments (Garrison et al., 2009). Teachers' embodiment and the use of social cues contribute to improved perceptions of social presence (Mayer, 2014; Richardson, 2001). The results of this study showed no statistically significant differences for social presence between the conditions. Participants may have doubted whether the onscreen instructor was AI-generated, when they were asked if they considered the teacher onscreen as a real person in the social presence questionnaire. Applications of generative artificial intelligence (AI) techniques are abundantly present on social media platforms that are frequented by children of primary school age (Ali et al., 2021). This may also explain the dynamic and subjective nature of the

construct social presence, when affected by personal attributes (Lyons et al., 2012). Children are not yet aware of the existence of AI-manipulated media (Ali et al., 2021), therefore AI-generated teachers may provide identical perceptions of social presence.

Mixed findings in the literature about the influence of instructor presence on cognitive load generates a necessity for more research to build understanding. Instructor presence may increase cognitive load (Choi et al., 2014; Colliot & Jamet, 2018; Mayer, 2021; Schroeder et al., 2017), but instructor presence and the use of social cues may also decrease cognitive load (Henderson & Schroeder, 2021; Price et al., 2016). The results of this study do not show the statistically significant differences that were expected for cognitive load between the conditions. This study has a young research population that is not familiar with or used to online education. Different forms of a teacher being present onscreen may not impact the cognitive load of the participants of this study, it remains however important to avoid overloading learners during learning (Skulmowski & Xu, 2022).

Various studies' results show that instructor presence, nurtured by the instructor's embodiment and the expression of social cues, is positively related to motivation (Baker, 2010; Richardson et al., 2017). In this study, no statistically significant differences were found for motivation between the conditions. The online nature of lessons may cause instructor presence to be perceived as less existing (Colliot & Jamet, 2018), especially when there is not a lot of interaction between the teacher and the students (Swan, 2001). The teacher plays a central role in influencing student motivation in online courses (Ladyshewsky, 2013). On the other hand, Henderson and Schroeder (2021) did not find compelling evidence in their systematic review that substantiates the necessity of a teacher being present for students to be motivated in online courses, which would explain the results of this study.

Instructor presence is considered to impact learning outcomes substantially (Jaggars et al., 2013; Wei et al., 2012). When strong instructor presence is perceived, students show

augmented learning outcomes (Bolliger, 2004; Henderson & Schroeder, 2021). Learning outcomes did not differ between the conditions, as the results of this study show no statistically significant differences. This may be explained by the results of a study by Homer et al. (2008) that also shows no significant differences on learning outcomes, when exploring instructor presence versus instructor absence, and argues whether instructor presence actually influences learning outcomes positively or not.

The correlation analyses showed connections between social presence and learning outcomes, cognitive load and learning outcomes, cognitive load and motivation, and motivation and learning outcomes. These outcomes are consistent with results of previous research that show these same connections, and make this study representative. Social presence is found to be an important construct in education, as it is significantly related to learning outcomes (Robb & Sutton, 2014; Weaver & Albion, 2005). The results of the correlation analyses show that when social presence decreases, learning outcomes improve. According to Yamada and Akahori (2007), social presence can aid communication, but it can also inhibit learning outcomes. Huang et al. (2020) show that cognitive load is a negative predictor of learning outcomes. The results of the correlation analyses confirm that when cognitive load increases, learning outcomes reduce. Also, the results show that cognitive load is positively associated with motivational beliefs, less cognitive load will lead to an augmented level of motivation (Paas, 1992; Paas et al., 2005). Finally, according to Sugiyanto et al. (2020), intrinsic motivation should be integrated into learning activities to improve learning outcomes, as when motivation improves, learning outcomes also improve.

4.1 Limitations and Future Research

The participants of this study were recruited from two primary schools. Although the results show that the research population was representative, this may have limits to the generalizability. For further study into the effectiveness of instructor presence within a

platform, it might be important to include participants from other primary schools. The main focus of this study was to research the effect of different forms of an instructor being present onscreen. Social presence, cognitive load, motivation, and learning outcomes were measured after participants had received an instruction. During the instruction, there was no interaction between the teacher and the students. Interaction between teacher and students could however contribute to improved learning (Kreijns et al., 2013; Li et al., 2019). Further research could include a condition with the teacher's entire body onscreen, expressing social cues while talking in a conversational style. This may contribute to perceptions of social presence (Moreno et al., 2001). Also, the lessons used in this study were prerecorded. A real time lesson might facilitate the interaction between teacher and student even more effectively.

During the research, participants sat behind each other. This allowed participants to see each other's screens. Further study should take this into account and create a setup where participants only see their own screen. Furthermore, this study was conducted with an instructor and an online situation, which was unfamiliar for participants. Although the results show no adverse effects of this finding and ensure this is a pure research, according to Sweller (2011), when students are more familiar with the instructor, social presence is improved and cognitive load is reduced by leaving enough working memory resources available for learning. Future research may look into the effects of an instruction given by a familiar instructor onscreen.

4.2 Practical Recommendations

Primary school students are generally habituated to face-to-face education and may therefore be overlooked in relation to online education. As a result, primary school students might also not have been researched extensively relative to virtual learning environments (Alemdag, 2022). However, coronavirus-pandemic has shown the importance of good quality online education for primary school students. After the pandemic these students experienced

difficulties in concentrating, reduction in motivation and connectedness (Bakx et al., 2020; Inspectie van het Onderwijs, 2022), and declines in learning outcomes (Azevedo et al., 2021).

The coronavirus-pandemic forced schools to put a large quantity of educational material online in a short time. The hectic change from face-to-face education to virtual education has become calmer, but the question remains how to create virtual learning environments that most effectively facilitate learning (Henderson & Schroeder, 2021). Improved learning experiences may have an important influence on society's welfare. It is necessary to build knowledge about the way students, including primary school students, learn best in virtual learning environments (Alemdag, 2022).

Mixed results are found on whether or not including an on-screen instructor facilitates learning more effectively (Alemdag, 2022; Henderson & Schroeder, 2021). Also, there is limited literature available comparing an on-screen instructor in a virtual learning environment to a condition without an on-screen instructor (Henderson & Schroeder, 2021), especially when it comes to primary school students. It is difficult to draw conclusions about the effects of human instructor presence, because most studies on instructor presence involve non-human characters (Alemdag, 2022). Based on the results of this study, no statements can be made concerning this matter. Yet it has become clear that an unknown teacher who is displaying gestures in a virtual learning environment, did not have a negative effect on primary school students either. It is presumed that in the long-term it is more effective to use technologies as are made possible with CloudClass. Following this study, the recommendation for primary schools is therefore to integrate these types of technologies into their online learning environment possibilities and that, in this way, primary schools are sufficiently equipped for future comparable situations such as coronavirus-pandemic.

4.3 Conclusion

To enable future theory development, this study contributes to knowledge that involves primary school students within virtual learning environments. Although the results showed that different forms of instructor presence did not affect the learning process in Dutch primary school students, no negative effects were found from being confronted with an unknown teacher in a virtual learning environment that participants were not used to. We are dealing with the tremendous speed in the development of new technologies such as CloudClass, that may meet students' needs in online learning, enhance instructor presence by enabling the creation of a feeling of teachers being physically and emotionally present, and provide good quality online education for primary school students. Primary schools will be able to prepare and equip themselves for sudden societal changes in the long-term, by integrating these new technologies in their online learning environments and in this way contribute to lasting motivation and learning performance.

References

Alemdag, E. (2022). Effects of instructor-present videos on learning, cognitive load, motivation and social presence: A meta-analysis. *Education and Information Technologies, 27*, 12713-12742. https://doi-org.ezproxy.elib11.ub.unimaas.nl/10.1007/s10639-022-11154-w

Ali, S., DiPaola, D., Lee, I., Sindato, V., Kim, G., Blumofe, R., & Breazeal, C. (2021). Children as creators, thinkers and citizens in an AI-driven future. *Computers and Education: Artificial Intelligence*, *2*, 100040. https://doi.org/10.1016/j.caeai.2021.100040

Azevedo, J. P., Hasan, A., Goldemberg, D., Geven, K., & Iqbal, S. A. (2021). Simulating the potential impact of COVID-19 school closures on schooling and learning outcomes: A set of global estimates. *The World Bank Research Observer, 36*(1), 1-40. https://doi.org/10.1093/wbro/lkab003

Baek, Y., Xu, Y., Han, S., & Cho, J. (2015). Exploring effects of intrinsic motivation and prior knowledge on student achievement in game-based learning. *Smart Computing Review, 5*(5), 368-377.

Baker, C. (2010). The impact of instructor immediacy and presence for online student affective learning, cognition, and motivation. *Journal of Educators Online, 7*(1), 1-30.

Bakx, A., Samsen-Bronsveld, E., Hornstra, L., Diepstraten, I., Speetjens, P., Van den Bergh, L., Denissen, J., & Van der Ven, S. (2020). *Het welbevinden en motivatie van kinderen in het basisonderwijs tijdens onderwijs op school en afstandsonderwijs: De visie van ouders.* Onderzoekswerkplaats POINT i.s.m. Nederlands Jeugdinstituut.

Bettinger, E., & Loeb, S. (2017). *Promises and pitfalls of online education.* Brookings.

Bolliger, D. U. (2004). Key factors for determining student satisfaction in online courses. *International Journal on E-Learning, 3*(1), 61–67.

Chen, O., Kalyuga, S., & Sweller, J. (2017). The expertise reversal effect is a variant of the more general element interactivity effect. *Educational Psychology Review, 29*, 393-405. https://doi.org/10.1007/s10648-016-9359-1

Chisadza, C., Clance, M., Mthembu, T., Nicholls, N., & Yitbarek, E. (2021). Online and face to face learning: Evidence from students' performance during the Covid-19 pandemic. *African Development Review, 33*(1), 114-125. https://doi.org.ezproxy.elib10.ub.unimaas.nl/10.1111/1467-8268.12520

Choi, H. H., Van Merriënboer, J. J. G., & Paas, F. (2014). Effects of the physical environment on cognitive load and learning: towards a new model of cognitive load. *Educational Psychology Review. 26*, 225-244. https://doi.org.ezproxy.elib11.ub.unimaas.nl/10.1007/s10648-014-9262-6

CloudClass (2023, 11 March). *CloudClass*. http://cloudclassproject.eu/

Colliot, T., & Jamet, É. (2018). Understanding the effects of a teacher video on learning from a multimedia document: an eye-tracking study. *Educational Technology Research and Development, 66*, 1415-1433. https://doi.org.ezproxy.elib11.ub.unimaas.nl/10.1007/s11423-018-9594-x

Cortina, J. M. (1993). What is coefficient alpha? An examination of theory and applications. *Journal of Applied Psychology, 78*(1), 98-104. https://doi.org/10.1037/0021-9010.78.1.98

Costley, J. (2019). The relationship between social presence and cognitive load. *Interactive Technology and Smart Education, 16*(2), 172-182. https://doi.org/10.1108/ITSE-12-2018-0107

Creswell, J. W. (2014). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research.* Pearson.

Decuypere, M., Grimaldi, E., & Landri, P. (2021). Introduction: Critical studies of digital education platforms. *Critical Studies in Education, 62*(1), 1-16. https://doi.org.ezproxy.elib10.ub.unimaas.nl/10.1080/17508487.2020.1866050

Delgado, J. M. D., Oyedele, L., Damien, P., & Beach, T. (2020). A research agenda for augmented and virtual reality in architecture, engineering and construction. *Advanced Engineering Informatics, 45*, 1-21. https://doi.org/10.1016/j.aei.2020.101122

Dunsworth, Q., & Atkinson, R. K. (2007). Fostering multimedia learning of science: Explaining the role of an animated agents' image. *Computers and Education, 49,* 677-690. https://doi.org/10.1016/j.compedu.2005.11.010

Ensmann, S., Whiteside, A., Gomez-Vasquez, L., & Sturgill, R. (2021). Connections before curriculum: The role of social presence during COVID-19 emergency remote learning for students. *Online Learning, 25*(3), 36-56. http://dx.doi.org/10.24059/olj.v25i3.2868

Faul, F. Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39*, 175-191. https://doi.org/10.3758/BF03193146

Field, A. (2018). *Discovering statistics using IBM SPSS statistics* (5th ed.). SAGE.

Garrison, D. R., Anderson, T., & Archer, W. (2000). Critical inquiry in a text-based environment: Computer conferencing in higher education. *The Internet and Higher Education, 2*(2), 87-105. https://doi.org/10.1016/S1096-7516(00)00016-6

Garrison, D. R., Anderson, T., & Archer, W. (2009). Critical thinking, cognitive presence, and computer conferencing in distance education. *American Journal of Distance Education, 15*(1), 7-23. https://doi.org.ezproxy.elib10.ub.unimaas.nl/10.1080/08923640109527071

Gorter, M. (2021). *An investigation of the effect of a pedagogical agent on achievement motivation, affect and learning for primary school students.* Open Universiteit.

Henderson, M. L., & Schroeder, N. L. (2021). A systematic review of instructor presence in instructional videos: effects on learning and affect. *Computers and Education Open, 2*, 1-10. https://doi.org/10.1016/j.caeo.2021.100059

Homer, B. D., Plass, J. L., & Blake, L. (2008). The effects of video on cognitive load and social presence in multimedia learning. *Computers in Human Behavior, 24*(3), 786-797. https://doi.org/10.1016/j.chb.2007.02.009

Hoogerheide, V., Loyens, S. M. M., & Van Gog, T. (2014). Comparing the effects of worked examples and modelling examples on learning. *Computers in Human Behavior, 41*, 80-91. https://doi.org/10.1016/J.CHB.2014.09.013

Huang, C. L., Luo, Y. F., Yang, S. C., Lu, C. M., & Chen, A. S. (2020). Influence of students' learning style, sense of presence, and cognitive load on learning outcomes in an immersive virtual reality learning environment. *Journal of Educational Computing Research, 58*(3), 596-615. https://doi.org/10.1177/0735633119867422

Inspectie van het Onderwijs (2022). *De staat van het onderwijs 2022*. Inspectie van het Onderwijs.

Jaggars, S. S., Edgecombe, N., & Stacey, G. W. (2013). *Creating an effective online instructor presence.* Community College Research Center, Columbia University.

Johnson, C. I., & Mayer, R. E. (2009). A testing effect with multimedia learning. *Journal of Educational Psychology, 101*(3), 621-629, https://doi.org/10.1037/a0015183

Kahan, B. C., Jairath. V., Doré, C. J., & Morris, T. P. (2014). The risks and rewards of covariate adjustment in randomised trials: An assessment of 12 outcomes of 8 studies. *Trials 15*(1), 139. https://doi.org/10.1186/1745-6215-15-139

Kalyuga, S., & Plass, J. L. (2018). Cognitive load as a local characteristic of cognitive processes: Implications for measurement approaches. In R. Z. Zheng (Ed.), *Cognitive load measurement and application: a theoretical framework for meaningful research and practice* (pp. 59-74). Routledge.

Kim, Y., & Baylor, A. L. (2016). Research-based design of pedagogical agent roles: A review, progress, and recommendations. *International Journal of Artificial Intelligence in Education*, *26*(1), 160-169. https://doi.org/10.1007/s40593-015-0055-y

Kim, Y., Baylor, A. L., & Shen, E. (2007). Pedagogical agents as learning companions: The impact of agent emotion and gender. *Journal of Computer Assisted Learning*, *23*(3), 220-234. https://doi.org/10.1111/j.1365-2729.2006.00210.x

Kreijns, K., Kirschner, P. A., & Vermeulen, M. (2013). Social aspects of CSCL environments: A research framework. *Educational Psychologist, 48*(4), 229-242. https://doi.org/10.1080/00461520.2012.750225

Kreijns, K., Weidlich, J., & Rajagopal, K. (2018). The psychometric properties of preliminary social presence measure using Rasch analysis. *Lecture Notes in Computer Science (including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 11082 LNCS,* 31-44. https://doi.org/10.1007/78-3-319-98572-5_3

Kreijns, K., Xu, K., & Weidlich, J. (2022). Social presence: conceptualization and measurement. *Educational Psychology Review, 34*, 139-170. https://doi.org/10.1007/s10648-021-09623-8

Ladyshewsky, R. (2013). Instructor presence in online courses and student satisfaction. *The International Journal for the Scholarship of Teaching and Learning, 7*(1), 1-23.

Leppink, J., Paas, F., Van der Vleuten, C. P. M., Van Gog, T., & Van Merriënboer, J. J. G. (2013). Development of an instrument for measuring different types of cognitive load. *Behavior Research Methods, 45*(4), 1058-1072. https://doi.org/10.3758/s13428-013-0334-1

Li, W., Wang, F., Mayer, R. E., & Liu, H. (2019). Getting the point: Which kinds of gestures by pedagogical agents improve multimedia learning? *Journal of Educational Psychology, 111*(8), 1382. https://doi.org/10.1037/edu0000352

Linnenbrink-Garcia, L., Durik, A. M., Conley, A. M., Barron, K. E., Tauer, J. M., Karabenick, S. A., & Harackiewicz, J. M. (2010). Measuring situational interest in academic domains. *Educational and Psychological Measurement, 70*(4), 647-671. https://doi.org/10.1177/0013164409355699

Lyons, A., Reysen, S., & Pierce, L. (2012). Video lecture format, student technological efficacy, and social presence in online courses. *Computers in Human Behavior, 28*(1), 181-186. https://doi.org/10.1016/j.chb.2011.08.025

Makransky, G., Terkildsen T. S., & Mayer, R. E. (2019). Adding immersive virtual reality to a science lab simulation causes more presence but less learning. *Learning and Instruction, 60*, 225-236. https://doi.org/10.1016/j.learninstruc.2017.12.007

Mayer, R. E. (2014). *The Cambridge handbook of multimedia learning* (2nd ed.). Cambridge University Press.

Mayer, R. E. (2021). Evidence-based principles for how to design effective instructional videos. *Journal of Applied Research in Memory and Cognition, 10*(2), 229-240. https://doi.org/10.1016/j.jarmac.2021.03.007

McAuley, E., Duncan, T. & Tammen, V.V. (1989). Psychometric properties of the Intrinsic Motivation Inventory in a competitive sport setting: A confirmatory factor analysis. *Research Quarterly for Exercise and sport, 60*, 48-58.

Meeter, M., Bele, T., Den Hartogh, C. F., Bakker, T., De Vries, R. E., & Plak, S. (2020). *College students' motivation and study results after COVID-19 stay-at-home orders.* Vrije Universiteit Amsterdam.

Moreno, R. (2005). Multimedia learning with animated pedagogical agents. In R. E. Mayer (Ed.), *The Cambridge handbook of multimedia learning* (pp. 507-523). Cambridge University Press.

Moreno, R., Reislein, M., & Ozogul, G. (2010). Using virtual peers to guide visual attention during learning: A test of the persona hypothesis. *Journal of Media Psychology, 22,* 52-60. https://doi.org/10.1027/1864-1105/a000008

Moreno, R., Mayer, R. E., Spires, H. A., & Lester, J. C. (2001). The case for social agency in computer based teaching: Do students learn more deeply when they interact with animated pedagogical agents? *Cognition and Instruction, 19*(2), 177-213. https://doi.org/10.1207/S1532690XCI1902_02

Nagel, L., & Kotzé, T. G. (2010). Supersizing e-learning: What a CoI survey reveals about teaching presence in a large online class. *The Internet and Higher Education, 13*(1), 45-51. https://doi.org/10.1016/j.iheduc.2009.12.001

Ng, Y. Y., & Przybyłek, A. (2021). Instructor presence in video lectures: Preliminary findings from an online experiment. *IEEE Access, 9*, 36485-36499.

Paas, F. G. (1992). Training strategies for attaining transfer of problem-solving skill in statistics: a cognitive-load approach. *Journal of Educational Psychology, 84*(4), 429-434. https://doi.org/10.1037/0022-0663.84.4.429

Paas, F. G., Van Merriënboer, J. J., & Adams, J. J. (1994). Measurement of cognitive load in instructional research. *Perceptual and Motor Skills, 79*(1), 419-430. https://doi.org/10.2466/pms.1994.79.1.419

Paas, F., Tuovinen, J. E., van Merriënboer, J. J., & Darabi, A. A. (2005). A motivational perspective on the relation between mental effort and performance: optimizing learner involvement in instruction. *Educational Technology Research and Development, 53*(3), 25-34.

Park, C., & Kim, D. G. (2020). Perception of instructor presence and its effects on learning experience in online classes. *Journal of Information Technology Education: Research, 19*, 475-488. https://doi.org/10.28945/4611

Peeters, W., (2023, 28 May). *Motivatie meten: 3 vragenlijsten (2018)*. Vernieuwenderwijs. https://www.vernieuwenderwijs.nl/motivatie-meten-2-vragenlijsten/

Price, S., Jewitt, C., & Sakr, M. (2016). Embodied experiences of place: A study of history learning with mobile technologies. *Journal of Computer Assisted Learning, 32*(4), 345-359. https://doi.org.ezproxy.elib10.ub.unimaas.nl/10.1111/jcal.12137

Richardson, J. C. (2001). *Examining social presence in online courses in relation to students' perceived learning and satisfaction.* State University of New York.

Richardson, J. C., Maeda, Y. L. J., & Caskurlu, S. (2017). Social presence in relation to students' satisfaction and learning in the online environment: A meta-analysis. *Computers in Human Behavior, 71*, 402-417. https://doi.org/10.1016/j.chb.2017.02.001

Robb, C. A., & Sutton, J. (2014). The importance of social presence and motivation in distance learning. *The Journal of Technology, Management, and Applied Engineering, 30*(2), 1-10.

Robertson, S. L. (2019). Comparing platforms and the new value economy in the academy. In R. Gorur, S. Sellar, & G. Steiner Khamsi, (Eds.), *World yearbook of education 2019* (pp. 169-186). Routledge.

Roque-Hernández, R. V., Díaz-Roldán, J. L., López-Mendoza, A., & Salazar-Hernández, R. (2021). Instructor presence, interactive tools, student engagement, and satisfaction in online education during the COVID-19 Mexican lockdown. *Interactive Learning Environments*, 1-14. https://doi.org.ezproxy.elib10.ub.unimaas.nl/10.1080/10494820.2021.1912112

Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: classic definitions and new directions. *Contemporary Educational Psychology, 25*, 54-67. https://doi.org/10.1006/ceps.1999.1020

Ryan, R. M., & Stiller, J. (1991). The social context of internalization: Parent and teacher influences on autonomy, motivation and learning. In P. R. Pintrich & M. L. Maehr (Eds.), *Advances in motivation and achievement* (Vol. 7, pp. 115-149). JAI Press.

Schiefele, U., Schaffner, E., Möller, J., & Wigfield, A. (2012). Dimensions of reading motivation and their relation to reading behavior and competence. Reading Research Quarterly, 47, 427-463. https://doi.org/10.1002/RRQ.030

Schuit, H., Vrieze, I., & Sleegers, P. (2011). *Leerlingen motiveren: een onderzoek naar de rol van leraren*. Open Universiteit, Ruud de Moor Centrum.

Short, J., Williams, E., & Christie, B. (1976). *The social psychology of telecommunications*. Wiley.

Skulmowski, A., & Xu, K. M. (2022). Understanding cognitive load and online learning: a new perspective on extraneous cognitive load. *Educational and Psychology Review, 34*, 171-196. https://doi.org/10.1007/s10648-021-09624-7

Sugiyanto, S., Mohammad, B., & Herpratiwi, H. (2020). The influence of learning motivation on the learning outcomes of vocational students at Lampung University. *International Journal of Advanced Science and Technology, 29*(05), 133-140.

Swan, K. (2001). Virtual interaction: Design factors affecting student satisfaction and perceived learning in asynchronous online courses. *Distance Education, 22*(2), 306-331. https://doi.org.ezproxy.elib10.ub.unimaas.nl/10.1080/0158791010220208

Sweller, J. (2004). Instructional design consequences of an analogy between evolution by natural selection and human cognitive architecture. *Instructional Science, 32*, 9-31. https://doi.org/10.1023/B:TRUC.0000021808.72598.4d

Sweller, J. (2011). Cognitive load theory. In *Psychology of learning and motivation* (Vol. 55, pp. 37-76). Academic Press.

Van Dijck, J., & Poell, T. (2018). Social Media Platforms and Education. In J. Burgess, A. Marwick, & T. Poell (Eds.), *The SAGE Handbook of Social Media* (pp. 579-591). SAGE.

Van Gool, T. (2022). *Digitale educatieve escaperooms als een betekenisvolle ervaring.* Eindhoven University of Technology.

Vimeo (2023, 2 November). *Vimeo*. https://vimeo.com/

Wang, J., & Antonenko, P. D. (2017). Instructor presence in instructional video: Effects on visual attention, recall, and perceived learning. *Computers in human behavior*, *71*, 79-89. https://doi.org/10.1016/j.chb.2017.01.049

Wang, J., Antonenko, P., Keil, A., & Dawson, K. (2020). Converging subjective and psychophysiological measures of cognitive load to study the effects of instructor-present video. *Mind, Brain, and Education, 14*(3), 279-291. https://doi.org/10.1111/mbe.12239

Weaver, C. M., & Albion, P. R. (2005). Momentum in online discussions: The effect of social presence on motivation for participation. *Proceedings of the 22nd Annual Conference of the Australasian Society for Computers in Learning in Tertiary Education (ascilite 2005)* (pp. 703-706).

Wei, C. W., Chen, N. S., & Kinshuk (2012). A model for social presence in online classrooms. Educational Technology Research and Development, 60, 529-545. https://doi-org.ezproxy.elib11.ub.unimaas.nl/10.1007/s11423-012-9234-9

Yamada, M., & Akahori, K. (2007). Social presence in synchronous CMC-based language learning: How does it affect the productive performance and consciousness of learning objectives? *Computer Assisted Language Learning, 20*(1), 37-65. https://doi-org.ezproxy.elib10.ub.unimaas.nl/10.1080/09588220601118503

Yilmaz, R., & Keser, H. (2017). The impact of interactive environment and metacognitive support on academic achievement and transactional distance in online learning. *Journal of Educational Computing Research, 55*(1), 95-122. https://doi.org/10.1177/0735633116656453

Yilmaz, R. M., Topu, F. B., Goktas, Y., & Coban, M. (2013). Social presence and motivation in a three-dimensional virtual world: An explanatory study. *Australasian Journal of Educational Technology, 29*(6), 823-839. https://doi.org/10.14742/ajet.425

Yu, Z. (2021). The effect of teacher presence in videos on intrinsic cognitive loads and academic achievement. *Innovations in Education and Teaching International, 59*(5), 574-585. https://doi.org.ezproxy.elib10.ub.unimaas.nl/10.1080/14703297.2021.1889394

Zhao, Q., & Li, W. (2016). Measuring perceptions of teachers' caring behaviors and their relationship to motivational responses in physical education among middle school students. *The Physical Educator, 73*(3), 510-529. https://doi.org/10.18666/TPE-2016-V73-I3-6505

Zilka, G. C., Cohen, R., & Rahimi, I. (2018). Teacher presence and social presence in virtual and blended courses. Journal of Information Technology Education, 17, 103-126. https://doi.org/10.28945/4061

Appendix A

Instructional Script and Examples of the Conditions

[DIA 1 laten zien]
Hoi, ik ben [naam]. Welkom bij de instructie kansrekenen en wat leuk dat je meedoet!
Na de instructie ga je weer een aantal opdrachten maken waarin je gaat kansrekenen. Kansrekenen gaat over toevalssituaties, je gaat uitrekenen hoe groot de kans is dat iets gebeurt. Je kunt niet met zekerheid zeggen dat iets gaat gebeuren, maar er zou een grotere kans kunnen zijn op de ene gebeurtenis dan op de andere. Als je met 2 dobbelstenen gooit heb je bijvoorbeeld een grotere kans op het gooien van totaal 6 dan totaal 10.
Ik zal je uitleggen hoe je kansen kunt berekenen met behulp van 2 voorbeelden waarin we twee kansen berekenen. In de opdrachten die je na deze instructie gaat maken, bereken je ook 2 kansen.
Laten we kijken en luisteren naar het eerste voorbeeld.
[DIA 2 laten zien]
De scouting heeft voor de deelnemers aan een spel gekleurde ballen meegenomen. Hier zie je eerst een rode bal [aanwijzen], daarnaast een blauwe bal [aanwijzen], daarnaast een gele bal [aanwijzen] en als laatst een groene bal [aanwijzen]. De deelnemers aan het spel mogen om de beurt een kleur bal kiezen. Zij vinden alle kleuren even mooi.
De vraag waar wij bij deze opdracht het antwoord op gaan uitrekenen is: “Wat is de kans dat de rode bal als eerste gekozen wordt en de groene bal als tweede gekozen wordt?”
Dit is een opdracht kansrekenen waarbij de volgorde belangrijk is. Zoals de vraag aangeeft, gaat het als eerste om de rode bal en als tweede om de groene bal. Dit is een opdracht zonder teruglegging. Dat betekent dat wanneer de rode bal gekozen is, deze niet nog een keer kan worden gekozen.
Als eerst gaan we de kans berekenen op het eerste deel van de vraag, de eerste gebeurtenis, namelijk de kans dat de rode bal als eerste gekozen wordt. Om deze kans te berekenen, is het nodig dat we eerst bepalen wat het aantal goede opties is en wat het aantal mogelijke opties is.
[DIA 3 laten zien]
Hier zie je weer alle ballen, alleen is de rode bal nu lager dan de andere ballen [aanwijzen]. Omdat alleen de rode bal de goede optie is, is het aantal goede opties 1. Omdat er in totaal 4 gekleurde ballen zijn, is het aantal mogelijke opties 4.
Om de kans te berekenen dat de rode bal als eerst gekozen wordt, gaan we het aantal goede opties delen door het aantal mogelijke opties. Dat betekent dat we 1 moeten delen door 4.

Hier zie je de 1 boven de streep [klikken en aanwijzen] en de 4 onder de streep [klikken en aanwijzen]. Dit betekent dat de kans dat de rode bal als eerst gekozen wordt $\frac{1}{4}$ is. Het antwoord op het eerste deel van de vraag is dus $\frac{1}{4}$ [aanwijzen].

Nu gaan we de kans berekenen op het tweede deel van de vraag, de tweede gebeurtenis, namelijk de kans dat de groene bal als tweede gekozen wordt. Om deze kans te berekenen is het weer nodig dat we eerst bepalen wat het aantal goede opties is en wat het aantal mogelijke opties is.

[DIA 4 laten zien]

Hier zie je weer alle ballen, alleen is de groene bal nu ook lager dan de andere ballen [aanwijzen]. Omdat alleen de groene bal de goede optie is, is het aantal goede opties 1. Omdat dit een opdracht zonder teruglegging is, doet de rode bal niet meer mee. Deze is al gekozen. Hierdoor is het aantal mogelijke opties 3. Stel dat de rode bal wel was teruggelegd, dan zou het aantal mogelijke opties weer alle 4 de gekleurde ballen zijn. Omdat de rode bal al door de eerste deelnemer is gekozen, zijn er nu nog maar 3 mogelijke opties over. Om de kans te berekenen dat de groene bal als tweede gekozen wordt, gaan we weer het aantal goede opties delen door het aantal mogelijke opties. Dat betekent dat we 1 moeten delen door 3. Hier zie je de 1 boven de streep [klikken en aanwijzen] en de 3 onder de streep [klikken en aanwijzen]. Dit betekent dat de kans dat de groene bal als tweede gekozen wordt $\frac{1}{3}$ is. Het antwoord op het tweede deel van de vraag is dus $\frac{1}{3}$ [aanwijzen].

Nu gaan we de antwoorden van de twee vragen samenvoegen om de kans te berekenen dat de rode bal als eerst gekozen wordt en de groene bal als tweede gekozen wordt.

[DIA 5 laten zien]

Hier kun je de berekening zien [klikken en aanwijzen]. We kunnen deze kans berekenen door de kans op de twee gebeurtenissen met elkaar te vermenigvuldigen, namelijk door $\frac{1}{4}$ [aanwijzen] te vermenigvuldigen met $\frac{1}{3}$ [aanwijzen]. $\frac{1}{4} \; x \; \frac{1}{3} = \frac{1}{12}$ [aanwijzen]. Het antwoord op de vraag “Wat is de kans dat de rode bal als eerst gekozen wordt en de groene bal als tweede gekozen wordt?”, is dus $\frac{1}{12}$.

Laten we kijken en luisteren naar het tweede voorbeeld.

[DIA 6 laten zien]

Vijf honden doen mee met een schoonheidswedstrijd. Het eerste deel van de wedstrijd vindt op maandag plaats en het tweede deel op dinsdag. De organisatie heeft vijf linten, elk lint

heeft een andere kleur. Hier zie je eerst het roze lint [aanwijzen], daarnaast het gele lint [aanwijzen], daarnaast het rode lint [aanwijzen], daarnaast het blauwe lint [aanwijzen] en als laatst het groene lint [aanwijzen]. De organisatie deelt de linten op de twee dagen willekeurig uit aan elke hond aan het begin van de wedstrijd.

De vraag waar wij bij deze opdracht het antwoord op gaan uitrekenen is: "Wat is de kans dat een hond op de eerste dag een geel lint krijgt en op de tweede dag een blauw lint?"

Net als bij het eerste voorbeeld, is bij deze opdracht kansrekenen de volgorde belangrijk. Zoals de vraag van de opdracht aangeeft, gaat het als eerst om het gele lint en als tweede om het blauwe lint. Het gaat hier om een opdracht met teruglegging, de gebeurtenis vindt op verschillende dagen plaats. Dat betekent dat wanneer de hond op de eerste dag van de schoonheidswedstrijd het gele lint krijgt, hij op de tweede dag ook weer het gele lint kan krijgen.

Als eerst gaan we de kans berekenen op het eerste deel van de vraag, de eerste gebeurtenis, namelijk de kans dat een hond op de eerste dag een geel lint krijgt. Om deze kans te berekenen, is het nodig dat we eerst bepalen wat het aantal goede opties is en wat het aantal mogelijke opties is.

[DIA 7 laten zien]

Hier zie je weer alle linten, alleen is het gele lint nu lager dan de andere linten [aanwijzen]. Omdat alleen het gele lint de goede optie is, is het aantal goede opties 1. Omdat er in totaal 5 gekleurde linten zijn, is het aantal mogelijke opties 5.

Om de kans te berekenen dat een hond op de eerste dag een geel lint krijgt, gaan we het aantal goede opties delen door het aantal mogelijke opties. Dat betekent dat we 1 moeten delen door 5. Hier zie je de 1 boven de streep [klikken en aanwijzen] en de 5 onder de streep [klikken en aanwijzen]. Dit betekent dat de kans dat een hond op de eerste dag een geel lint krijgt $\frac{1}{5}$ is. Het antwoord op het eerste deel van de vraag is dus $\frac{1}{5}$ [aanwijzen].

Nu gaan we de kans berekenen op het tweede deel van de vraag, de tweede gebeurtenis, namelijk de kans dat een hond op de tweede dag een blauw lint krijgt. Om deze kans te berekenen is het weer nodig dat we eerst bepalen wat het aantal goede opties is en wat het aantal mogelijke opties is.

[DIA 8 laten zien]

Hier zie je weer alle linten, alleen is het blauwe lint nu lager dan de andere linten [aanwijzen]. Omdat alleen het blauwe lint de goede optie is, is het aantal goede opties weer 1. Omdat dit een opdracht met teruglegging is, doet het gele lint weer mee. Hierdoor is het aantal mogelijke

opties weer 5. Om de kans te berekenen dat een hond op de tweede dag een blauw lint krijgt, gaan we nu het aantal goede opties delen door het aantal mogelijke opties. Dat betekent dat we 1 moeten delen door 5. Hier zie je de 1 boven de streep [klikken en aanwijzen] en de 5 onder de streep [klikken en aanwijzen]. Dit betekent dat de kans dat een hond op de tweede dag een blauw lint krijgt $\frac{1}{5}$ is. Het antwoord op het tweede deel van de vraag is dus $\frac{1}{5}$ [aanwijzen].

Nu gaan we de antwoorden op de twee vragen samenvoegen om de kans te berekenen dat een hond op de eerste dag een geel lint krijgt en op de tweede een blauw lint.

[DIA 9 laten zien]

Hier kun je de berekening zien [klikken en aanwijzen]. We kunnen deze kans berekenen door de kans op de twee gebeurtenissen met elkaar te vermenigvuldigen, namelijk door $\frac{1}{5}$ [aanwijzen] te vermenigvuldigen met $\frac{1}{5}$ [aanwijzen]. $\frac{1}{5} \; x \; \frac{1}{5} = \frac{1}{25}$ [aanwijzen]. Het antwoord op de vraag “Wat is de kans dat een hond op de eerste dag een geel lint krijgt en op de tweede dag een blauw lint?” is dus $\frac{1}{25}$.

[DIA 10 laten zien]

Dit was de instructie kansrekenen. Als je wilt, kan je de video nog een keer bekijken. Als je het begrijpt, mag je eerst een paar vragen beantwoorden en de opdrachten maken. Bij de opdrachten schrijf je het antwoord op de vraag in het vakje onder de opdracht. Ook schrijf je in het vakje welke berekening je hebt gebruikt om het antwoord te krijgen.

Pak je pen en laten we beginnen!

End.

Appendix B

Images of the Conditions

Control condition

Experimental condition 1

Experimental condition 2

Appendix C

Social Presence Questionnaire

Zet een rondje om het goede cijfer.

Van 1 = *helemaal waar* tot 10 = *helemaal niet waar*

In de video van de les kansrekenen…

1	…voelt het alsof ik te maken heb met een echte leraar.	1 2 3 4 5 6 7 8 9 10
2	…voelt het alsof de leraar een echt persoon is.	1 2 3 4 5 6 7 8 9 10
3	…voelt het alsof de leraar in dezelfde kamer is.	1 2 3 4 5 6 7 8 9 10
4	…voelt het alsof de leraar in de buurt is.	1 2 3 4 5 6 7 8 9 10
5	…voelt het alsof ik goed contact heb met de leraar.	1 2 3 4 5 6 7 8 9 10

Kreijns, K., Bijker, M., & Weidlich, J. (2020). A Rasch analysis approach to the development and validation of a social presence measure. In M. S. Khine (Ed.), *Rasch measurement: Applications in quantitative educational research* (Chapter 11). Springer Singapore. https://doi.org/10.1007/978-981-15-1800-3

Appendix D

Cognitive Load Index (CLI)

Zet een rondje om het goede cijfer Van 1 = *helemaal niet het geval* tot 10 = *helemaal het geval*		
1	Het onderwerp van de video les kansrekenen was erg ingewikkeld.	1 2 3 4 5 6 7 8 9 10
2	Ik ervaar de video les kansrekenen als erg ingewikkeld.	1 2 3 4 5 6 7 8 9 10
3	De oplossingsmethode in de video les kansrekenen heb ik als erg ingewikkeld ervaren.	1 2 3 4 5 6 7 8 9 10
4	De uitleg tijdens de video les over kansreken was… Van 1 = *heel duidelijk* tot 10 = *heel onduidelijk*	1 2 3 4 5 6 7 8 9 10
5	De uitleg tijdens de video les over kansrekenen waren voor het leren… Van 1 = *heel bruikbaar* tot 10 = *helemaal niet bruikbaar*	1 2 3 4 5 6 7 8 9 10
6	De taal die gebruikt werd bij de uitleg tijdens de video les kansrekenen was… Van 1 = *heel duidelijk* tot 10 = *heel onduidelijk*	1 2 3 4 5 6 7 8 9 10
7	Ik begreep de oplossingsmethode van de video les kansrekenen volledig.	1 2 3 4 5 6 7 8 9 10
8	Ik begreep de meeste lesstof die in de video les kansrekenen werd uitgelegd.	1 2 3 4 5 6 7 8 9 10
9	Ik begreep hoe alle onderdelen van de video les kansrekenen met elkaar te maken hadden.	1 2 3 4 5 6 7 8 9 10
10	Ik kon de nieuwe dingen die ik in de video les kansrekenen heb geleerd samenvoegen met wat ik al wist over rekenen.	1 2 3 4 5 6 7 8 9 10

Leppink, J., Paas, F., Van der Vleuten, C. P. M., Van Gog, T., & Van Merriënboer, J. J. G. (2013). Development of an instrument for measuring different types of cognitive load. *Behavior Research Methods, 45*(4), 1058-1072. https://doi.org/10.3758/s13428-013-0334-1

Cognitive Load Index (CLI), additional items

Bewering 1. Lees de uitspraak hieronder en kies vervolgens één antwoord dat het meest op jou van toepassing is uit negen antwoord-categorieën (*(1) heel, heel weinig mentale inspanning, (2) heel weinig mentale inspanning, (3) weinig mentale inspanning, (4) redelijk weinig mentale inspanning, (5) niet weinig / niet veel mentale inspanning, (6) redelijk veel mentale inspanning, (7) veel mentale inspanning, (8) heel veel mentale inspanning en (9) heel, heel veel mentale inspanning*). Er is geen enkel antwoord goed of fout.

Kruis alsjeblieft met één *X* aan wat het meest op jou van toepassing is.	Heel, heel weinig mentale inspanning (1)	Heel weinig mentale inspanning (2)	Weinig mentale inspanning (3)	Redelijk weinig mentale inspanning (4)	Niet weinig / niet veel mentale inspanning (5)	Redelijk veel mentale inspanning (6)	Veel mentale inspanning (7)	Heel veel mentale inspanning (8)	Heel, heel veel mentale inspanning (9)
De video les kansrekenen die ik net gezien heb, kostte mij:	☐	☐	☐	☐	☐	☐	☐	☐	☐

Bewering 2. Lees de uitspraak hieronder en kies vervolgens één antwoord dat het meest op jou van toepassing is uit negen antwoord-categorieën (*(1) heel, heel erg makkelijk, (2) heel erg makkelijk, (3) makkelijk, (4) redelijk makkelijk, (5) niet makkelijk en niet moeilijk, (6) redelijk moeilijk, (7) moeilijk, (8) heel moeilijk en (9) heel, heel moeilijk*). Er is geen enkel antwoord goed of fout.

Kruis alsjeblieft met één *X* aan wat het meest op jou van toepassing is.	Heel, heel erg makkelijk (1)	Heel erg makkelijk (2)	Makkelijk (3)	Redelijk makkelijk (4)	Niet makkelijk en niet moeilijk (5)	Redelijk moeilijk (6)	Moeilijk (7)	Heel moeilijk (8)	Heel, heel moeilijk (9)
De video les kansrekenen die ik net gezien heb was:	☐	☐	☐	☐	☐	☐	☐	☐	☐

Leppink, J., Paas, F., Van der Vleuten, C. P. M., Van Gog, T., & Van Merriënboer, J. J. G. (2013). Development of an instrument for measuring different types of cognitive load. *Behavior Research Methods, 45*(4), 1058-1072. https://doi.org/10.3758/s13428-013-0334-1

Appendix E

Intrinsic Motivation Inventory (IMI): Interest and Enjoyment

Zet een rondje om het goede cijfer Van 1 = *past helemaal niet bij mij* tot 7 = *past helemaal bij mij*		
1	Ik vond de video les kansrekenen erg leuk om te doen.	1 2 3 4 5 6 7 8 9 10
2	Ik vond de video les kansrekenen erg interessant.	1 2 3 4 5 6 7 8 9 10
3	De video les kansrekenen was leuk om te doen.	1 2 3 4 5 6 7 8 9 10
4	Ik vond het erg leuk om de video les kansrekenen te doen.	1 2 3 4 5 6 7 8 9 10
5	Ik vond de video les kansrekenen erg saai.	1 2 3 4 5 6 7 8 9 10
6	Ik vond de video les kansrekenen erg interessant.	1 2 3 4 5 6 7 8 9 10
7	Ik zou de video les kansrekenen als ‘erg leuk’ omschrijven.	1 2 3 4 5 6 7 8 9 10

Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: classic definitions and new directions. *Contemporary Educational Psychology, 25*, 54-67. https://doi.org/10.1006/ceps.1999.1020

Appendix F

Knowledge Test Probability Calculations

1) Tijdens de kerstviering mogen 11 basisschoolleerlingen, waaronder Hans en Iris, een kerstverhaal vertellen aan de klas tijdens het diner. De leraar bepaalt de volgorde waarin de leerlingen mogen vertellen. Wat is de kans dat Hans als eerst mag vertellen en Iris als tweede?
2) Op een zaterdag en een zondag rennen paarden de jaarlijkse paardenrace. De paarden willen de finish zo snel mogelijk bereiken. In totaal zijn er 6 paarden die de race op zaterdag en op zondag rennen, hun namen zijn: Bas, Niels, Anne, Jan, Martine en Kim. Je weet niet welk paard het snelst kan rennen. Wat is de kans dat Bas op zaterdag het snelst over de finish komt en Martine op zondag?
3) Op een koude zondag en maandag vangen vissers één voor één een vis uit een meer. Er zwemmen 4 vissen in het meer, één baars, één snoek, één brasem en één paling. Wat is de kans dat de vissers de brasem op zondag vangen en de snoek op maandag?
4) Bij ganzenbord kan een speelster alleen winnen als zij een bepaalde combinatie gooit met een gewone dobbelsteen (1 tot en met 6 op de 6 zijden). Om te winnen moet zij eerst een 4 gooien voor een veilige plek en daarna een 1. Hoe groot is de kans dat zij eerst een 4 gooit en daarna een 1?
5) Er zijn 14 kinderen op een verjaardagsfeestje. Alle kinderen krijgen om de beurt een versierde cupcake. Je voorspelt welke cupcake als eerste wordt uitgedeeld en welke als tweede. Wat is de kans dat je voorspelling goed is?
6) Er zijn 14 apen in een grote kooi in een dierentuin. Deze apen worden allemaal op woensdag en op zaterdag gewassen door de verzorgers. Jij mag voorspellen welke aap op woensdag als eerste wordt gewassen en welke aap op zaterdag als eerste wordt gewassen. Hoe groot is de kans dat je voorspelling goed is?
7) 5 kinderen doen mee met een wielerwedstrijd. Het eerste deel van de wedstrijd vindt plaats op zaterdag en het tweede deel op zondag. De organisatie heeft 5 helmen en elke helm heeft een andere kleur (groen, blauw, geel, rood en oranje). De organisatie deelt de helmen willekeurig uit bij de start op beide dagen. Hoe groot is de kans dat een fietser op de eerste dag een rode helm krijgt en op de tweede dag een blauwe helm?
8) In de finale van Boer zoekt Vrouw zijn 8 vrouwen die strijden om de liefde van een boer. Ze zijn alle 8 even leuk. Wat is de kans dat je goed voorspelt welke vrouw de wedstrijd wint en welke vrouw als tweede eindigt?

Appendix G

Prior Knowledge Test Probability Calculations

1) Op dierendag springen sprinkhanen tijdens een wedstrijd zo ver als ze kunnen. In totaal zijn er 6 sprinkhanen die springen in de wedstrijd, hun namen zijn: Jaap, Eva, Sofie, Tamara, Fred en Remy. Je weet niet welke sprinkhaan het verst kan springen. Hoe groot is de kans dat Eva als eerste eindigt en Fred als tweede?
2) In de finale van de Voice of Holland strijden 8 zangers om een platencontract. Ze zijn allemaal even goed. Hoe groot is de kans dat je goed voorspelt wie op de eerste plek eindigt en wie op de tweede plek?
3) Op een zaterdag bestaat een voetbalteam uit 11 spelers, waaronder Ricardo en Jay. Na de wedstrijd gaan de spelers één voor één op het doel schieten. De coach bepaalt wie er mag schieten. Hoe groot is de kans dat Ricardo als eerst mag schieten en Jay als tweede?
4) Er zijn 6 honden over in een asiel die een nieuw baasje zoeken. Alle 6 honden zijn even leuk. Hoe groot is de kans dat je precies voorspelt welke hond als eerste een nieuw baasje vindt en welke hond als tweede?