MASTER'S THESIS

Een Onderzoek naar het Effect van Mindset op Cognitieve Belasting, Situationele Interesse en Prestaties.

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Een Onderzoek naar het Effect van Mindset op Cognitieve Belasting, Situationele Interesse en Prestaties

An Investigation of the Effect of Mindset on Cognitive Load, Situational Interest, and Performance

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Samenvatting

Vergeleken met leerlingen uit andere landen hebben Nederlandse basisschoolleerlingen een lagere motivatie om te leren (OECD, 2019). Het is van belang dat lerenden weten dat ze door hun mindset invloed hebben op hun motivatie en leerresultaten (Haimovitz & Dweck, 2017). Lerenden met een *fixed mindset* gaan ervan uit dat karakter, persoonlijkheid en intelligentie vaststaande gegevens zijn en dat ze hier niet veel verandering in aan kunnen brengen (Dweck & Leggett, 1988; Dweck, 2006). Daarentegen hebben lerenden met een *growth mindset* de overtuiging dat ze capaciteiten kunnen ontwikkelen door bijvoorbeeld hard te werken. Zij hebben vaak de motivatie om te leren en tonen doorzettingsvermogen (Dweck & Yeager, 2019; Haimovitz & Dweck, 2017; Dweck & Leggett, 1988). Onderzoek in de cognitieve belastingstheorie laat zien dat lerenden hogere motivatie en leerprestaties laten zien bij effectief en efficiënt ontwikkelde instructies. Dit is ook van invloed op de mate waarin de lerende cognitieve belasting ervaart (Sweller, 2010; Van Merriënboer & Kirschner, 2007). Daarnaast laat onderzoek naar Situationele Interesse zien dat lerenden met een growth mindset meer interesse tonen in nieuwe onderwerpen en in staat zijn hun interesse vast te houden wanneer de taak complexer wordt (O'Keefe et al., 2018). Eerder onderzoek naar growth mindset heeft vooral plaatsgevonden in het universitair en voortgezet onderwijs. Er zijn weinig studies bekend over onderzoek bij kinderen in groep 7 en 8 van het basisonderwijs. Het doel van dit onderzoek was om de rol van een growth mindset interventie op het leren van lerenden in het basisonderwijs te onderzoeken en om meer inzicht te krijgen in de invloed ervan op cognitieve belasting, situationele interesse en prestaties bij het oplossen van kansberekeningsproblemen. Dit onderzoek was een gerandomiseerd experimenteel onderzoek, gebaseerd op een steekproef van 96 lerenden uit groep 7 en 8 van twee basisscholen in Nederland. Het onderzoek bestaat uit twee groepen waarin de lerenden ad random zijn toegewezen aan de interventie- (n = 49) versus de controleconditie (n = 47).

Tijdens het experiment werd er door de lerenden gewerkt aan een growth mindset taak, ofwel controletaak. Aansluitend werd er een video met instructie over kansberekeningsproblemen aangeboden. Het verband tussen growth mindset op cognitieve belasting, growth mindset op situationele interesse en growth mindset op prestaties werd onderzocht. Uit de resultaten bleek dat de lerenden in de experimentele conditie na de interventie een hogere growth mindset apporteerden dan lerenden in de controleconditie. Verder werd er geen significant verschil gevonden op het effect van growth mindset op cognitieve belasting, situationele interesse en prestaties. Deze bevindingen komen overeen met de bevindingen uit enkele eerdere onderzoeken onder universiteitsstudenten en volwassenen. Voor vervolgonderzoek is het interessant om het effect van growth mindset te onderzoeken binnen andere onderwijsconcepten. Daarnaast is het van belang dat de complexiteit en lengte van het onderzoek aangepast wordt om leerlingen tijdens het onderzoek gemotiveerd te houden.

Trefwoorden: growth mindset, cognitieve belasting, situationele interesse, prestaties

Abstract

Compared to learners from other countries, Dutch primary school learners have a lower motivation to learn (OECD, 2019). It is important for learners to know that they can influence motivation and performance through their mindset (Haimovitz & Dweck 2017). Learners with a fixed mindset assume that character, personality, and intelligence are fixed and that they cannot change them much (Dweck & Legett, 1988; Dweck, 2006). In contrast, learners with a growth mindset are convinced that they can develop their capabilities through, for example, hard work. They often have the motivation to learn and show perseverance (Dweck & Yeager, 2019; Haimovitz & Dweck, 2017; Dweck & Leggett, 1988). Research in cognitive load theory shows that learners show higher motivation and learning performance when instructions are effectively and efficiently developed. This also influences the degree to which cognitive load is experienced (Sweller, 2010; Van Merriënboer & Kirschner, 2007). In addition, research on Situational Interest shows that learners with a growth mindset show more interest in new topics and are able to maintain their interest when the task becomes more complex (O'Keefe et al., 2018). Previous research on growth mindset has mainly taken place in university and secondary education. Few studies are known about research with children in grade 7 and 8 of primary school. The aim of this study was to investigate the role of a growth mindset intervention on learning of primary school students of grade 7 and 8 and to gain more insight into the conditions for learning such as cognitive load and situational interest. This study is a randomised experimental study, based on a sample of 96 learners from grade 7 and 8 from two primary schools in the Netherlands. The study consisted of two groups in which the learners were randomly assigned to the growth mindset (n = 49) versus control condition (n = 47). During the experiment, the learners worked on a growth mindset task or control task. This was followed by a video instruction on probability problems. The relationship between growth mindset and cognitive load, situational interest and performance was examined. The results showed that, after the intervention, the learners in the experimental condition reported a higher growth mindset than learners in the control condition. Furthermore, no significant difference was found in the effect of growth mindset on cognitive load, growth mindset on situational interest and growth mindset on performance. These findings are consistent with the findings from several previous studies among university students and adults. For further research, it would be interesting to investigate the effect of growth mindset within other educational concepts. Furthermore, it is important that the complexity and length of the study are adapted to keep students motivated during the study.

Keywords: growth mindset, cognitive load, situational interest, performance

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The Effect of Mindset on Cognitive Load, Situational Intrest, and Performance

1. Introduction

Research on motivation and learner performance, which has been conducted over decades, shows that motivation is important for successful learning (Wijsman et al., 2018). For this, it is important that learners have the conviction that competences can be developed and that they can influence success and setbacks. This conviction about mindset can be traced back to research by Dweck and Legett (1988), who formulated a theory about growth mindset. They claimed that learners with a growth mindset have the conviction that they can develop capabilities and work on their personal development (Dweck, 2006; Dweck & Yeager, 2019), while learners with a fixed mindset have the conviction that capabilities are fixed with the result that they avoid situations they are less good at (Dweck, 2006).

Compared to learners from other countries, Dutch primary school learners have a lower motivation to learn (OECD, 2019). This finding is internationally supported by research within primary education by the *Nederlandse Inspectie van het Onderwijs* (2019). This research indicates that Dutch primary schools struggle to motivate their learners. A growth mindset is important for primary school learners because it can have a fundamental influence on their motivation and learning outcomes. In addition, adopting a growth mindset can have a positive effect on reducing the cognitive load experienced by learners and increase learning performance (Haimovitz & Dweck, 2017; Yeager & Dweck, 2012). For this, it is important that learners understand that brains are constantly evolving and that they can influence this by themselves (Dweck, 2006; Dweck & Yeager, 2019).

While the research of Dweck and Leggett (1988) started in primary education, there was soon a shift to secondary and higher education. In the past few years, research into growth mindset has mainly focused on the relationship between motivation (Blackwell et al., 2007). Recent research on motivation and growth mindset mainly focuses on secondary education (Dweck & Yeager, 2019; Xu et al., 2020).

By focusing on growth mindset in primary education, children learn at an early age that their brains are flexible and can be developed. This study wants to contribute to filling the gap in literature concerning the effect of growth mindset in children and aims to investigate a growth mindset intervention on cognitive load, situational interest and performance of learners in grade 7 and 8 of primary school. In the theoretical framework, the various themes of this study are elaborated upon.

1.1 Theoretical Framework

The theoretical framework provides an overview of the main literature and the current state of research. First, the growth mindset and growth mindset in children will be described (Section 1.1.1 and 1.1.2). Subsequently, a connection between this research and the cognitive load theory is reported (Section 1.1.3). Lastly, a connection with situational interest has been reported (Section 1.1.4).

1.1.1 Growth mindset

People may think differently about whether traits such as intelligence or personality are fixed or can be shaped and developed (Dweck & Yeager, 2019). Research has shown that people have more capacities to continue learning and developing their knowledge and skills throughout their lives than was ever expected (Blackwell et al., 2007; Dweck, 2006). People are born with differences in temperament and basic intelligence, but it is clear that life experiences, education and personal commitment have an impact. The way a person leads his life can determine whether he becomes the person he wants to be and whether he stands up for the things he values (Dweck, 2006). These different beliefs about the ability to grow for certain traits are called implicit ways of thinking. They are described that way because they were potentially falsifiable ideas about what intelligence is and how it might work. They are rarely made explicit (Dweck & Yeager, 2019; Haimovitz & Dweck, 2017).

Implicit theories create a framework for making predictions and assessing the meaning of events in one's world (Yeager & Dweck, 2012). Two types of mindsets can be distinguished: the fixed mindset and the growth mindset (Elliott & Dweck, 1988). The conviction that one's qualities are fixed, the fixed mindset, creates the urge to prove oneself over and over again. Learners with this mindset assume that character, personality, and intelligence are fixed facts and that there is not much they can do to change them (Dweck, 2006).

On the other hand, the growth mindset assumes that learners can develop. Growth mindset is based on the conviction that human qualities are not fixed, but can develop over time by making an effort. Learners with this mindset believe that they can improve their abilities through, for example, hard work, good strategy use and instructions from others. They believe that they are able to change to 'grow' through learning and experience (Dweck & Yeager, 2019; Haimovitz & Dweck, 2017; Blackwell et al., 2007; Dweck & Leggett, 1988). Dweck (2017) suggests that mindsets are an important part of personality and can create characteristic and recurring patterns of behaviour. In addition, learners may have different mindsets in different areas (Mueller & Dweck, 1998) and the most strongly represented mindset (fixed or growth) will strongly influence goals, attributions, and behaviour.

There is still much to be learned about how knowledge about growth mindset can be integrated into education. Most learners are in between a fixed or a growth mindset; mindset can change through events or over time through specific interventions (Dweck, 2017). Research by Dweck (2000) found that over 60% of first year secondary school learners believe that they are born with strengths and weaknesses in learning and that they cannot change these perceptions. Inspired by this research, Ricci (2013) started research in the middle and lower grades of her primary school. Learners in the kindergarten classes came to school with the feeling that they can learn and become successful. The higher the group, the more often children thought that intelligence is fixed, and they cannot develop further. This illustrates the importance of children learning that they can develop. Dweck and Yeager (2019) recommend for further research to investigate how growth mindset tasks can be integrated into classroom teaching. They describe that teachers can be an important factor in providing knowledge about growth mindset.

1.1.2 Growth mindset in children

Mindsets play an important role in the interpersonal processes, motivation, self-regulation, and performance of children. They help them to develop, also in their social-emotional skills (Dweck, 1999). Empirical research among young children showed that children as young as three and a half years old already show a helpless reaction when confronted with failure. The children showed, for example, negative feelings, signs of self-blame, and little perseverance (Cain & Dweck, 1995; Heyman et al., 1992). According to Cain et al. (1995), this is not yet attributable to implicit theories. When children reach the age of 7 to 8 years, these theories gain more influence on their behaviour, which can be seen, for example, in comparing oneself to other children. With learners around 10 to 12 years of age, the characteristics of a fixed or growth mindset are more visible (Dweck, 2002; Dweck, 2003).

According to Dweck et al. (2014), knowledge about mindsets is a valuable tool in the development of children and in taking responsibility for their own learning. This is supported by Bialik and Fadel (2015), who suggest that if young children are equipped with knowledge about developing their mindsets, this can influence their future academic success in a positive way. Blackwell et al. (2007, study 1) followed learners from a US junior high school during a five-year study. They found that learners with a growth mindset were more motivated to learn than learners with a fixed mindset and that this difference increased over time. Because of the difference in mindset, a difference in the grades achieved was also visible.

In another study of math learning skills among 13- and 14-year-old learners, Blackwell et al. (2007, study 2) observed a difference in engagement in math and math grades after a growth mindset intervention. During this study, half of the learners was taught about the different forms of memory and the other half received training about growth mindset and how they could apply this in their schoolwork. The learners with the mindset intervention showed a threefold increase in effort and commitment compared to the control group. In addition, the control group continued to get worse grades than previous results, while the math grades of the intervention group showed a positive change. These studies suggest that knowledge about growth mindset can have a positive effect on the promotion of math learning and the results achieved. In the same study, Blackwell et al. (2007) write that learners become smarter when they step outside their comfort zone to learn new things. Neurons in the brain form new, stronger connections. Through the knowledge of mindset, learners discovered that they could become smarter and grow through difficulties and setbacks.

Researchers regularly check or repeat Carol Dweck's studies. For example, more recent large-scale meta-studies (Bahník & Vranka, 2017; Sisk et al., 2018) of learners at the beginning of high school show that interventions based on mindset theory have a positive but small effect on learners' learning outcomes. This is confirmed by Dweck (2018), who indicates, however, that meta-studies can give a distorted picture. There may be a small effect on the average learning performance of learners, while in individual cases a larger effect may be visible. Research into growth mindset and factors such as cognitive load, performance, and motivation is primarily conducted within secondary education (Van Merriënboer & Sweller, 2004; Paas & Van Merriënboer, 1994; Xu et al., 2020). Few studies among children in grade 7 and 8 of primary school are known so far.

1.1.3 Cognitive load theory

Growth mindset has been shown to affect the cognitive processes during learning (Xu et al., 2020), in particular the cognitive load perceptions. According to Sweller et al. (1998), cognitive load is a construct that represents the load that the performance of a certain task places on the cognitive system, specifically on working memory. The cognitive load theory is a theory based on the human cognitive architecture that consists of long-term memory, or sensory memory, where knowledge and skills are permanently stored, and short-term memory, or working memory, where incoming information is processed (Cooper, 1998). Working memory is a function of the brain that is involved in the retention and processing of information (Gathercole & Alloway, 2008). Working memory has a limited capacity, which accounts for the limited cognitive load a learner can endure (Van Merriënboer & Kirschner, 2007). If the visual and auditory channel are used simultaneously in the processing of information, the capacity of working memory can be increased. All information processed by the working memory can be stored in the unrestricted long-term memory. This takes the form of hierarchically organised schemas, which can vary in their degree of automaticity. The function of these schemas is twofold: to store information in long-term memory and to reduce the load on working memory (Sweller et al., 1998; Kirschner et al., 2010).

The structure of information within a task and a learner's information process determine the load a learner experience (Paas et al., 2003). A task with high complexity is experienced as cognitively more demanding than a task with low complexity (Sweller et al., 1998). Research showed that within the cognitive load theory the cognitive load on working memory can be subdivided into three types of load: (a) Intrinsic Cognitive Load (ICL), (b)

Extraneous Cognitive Load (ECL) and (c) Germane Cognitve Load (GCL) (Sweller et al., 1998; Van Merriënboer & Kirschner, 2007). ICL is created by the intrinsic complexity of the information (Sweller, 2010). This involves the number of elements of the information that must be processed simultaneously (Van Merriënboer & Kirschner, 2007). The second form of load, ECL, arises from information that is irrelevant or ineffective, for example an instruction that is not clearly designed (Sweller, 2010). GCL, the last type of load, arises through the acquisition of knowledge and activities that contribute to the learning process, such as effectively designed instructions (Sweller et al., 1998; Sweller, 2010). It is related to processes that directly contribute to learning (Van Merriënboer & Kirschner, 2007). Learners experience cognitive load when processing new information due to the limited processing capacity of working memory.

To design an effective and efficient instruction and information process for learners, it is important to balance the different forms of cognitive load. Instruction designed according to these principles results in higher learning outcomes for learners (Cooper & Sweller 1987; Sweller & Cooper, 1985). It is expected that learners with a growth mindset remain engaged in learning, have a positive view of challenges within a task, show perseverance (Dweck & Master, 2008), and that this influences the extent to which the learner experiences cognitive load. The outcome of recent research by Xu et al. (2020) among 138 learners in secondary education is in line with these findings. In this study, a group of learners received a growth mindset intervention prior to a lesson; the learners in the control group did not. The results of the study show that the learners in the intervention group embrace knowledge and skills and focus on further development of knowledge and skills. In addition, these learners experience a lower cognitive load and have deeper understanding of the offered material. As far as known, little research has been done into the effect of growth mindset on cognitive load in primary education. It is expected that a growth mindset intervention will result in lower ICL, ECL and GCL.

1.1.4 Situational Interest

Growth mindset has a positive influence on the development of interest (Harackiewicz et al., 2002). Learners with a growth mindset regarding interest development show more interest in new areas and are able to maintain their interest when the task becomes more complex (O'Keefe et al., 2018). Interest is described by Hidi and Renninger (2006) as a state of mind in which attention or engagement in a particular subject exists, which also influences learners' goals and outcomes. Interest is essential for learners to be able to progress and is seen as a continuous process (Harackiewicz et al. 2008). The four-stage model of Hidi and Renninger (2006) makes a distinction between two concepts of interest: personal interest and situational interest (SI).

Personal interest is characterised by a comparative stable preference of learners for certain subjects or contents and is internally activated. The learner will take action to answer learning questions and show long-term and repeated commitment and enjoyment (Hidi & Renninger, 2006; Harackiewicz et al. 2008). SI is a form of interest that often is externally triggered and the development of it depends on the environment (Hidi, 2000; Hidi & Renninger, 2006; Linnenbrinck-Garcia et al., 2010). SI may also arise as a result of task involvement, which may cause the learner to want to develop (Harackiewicz et al., 2008). SI is seen as a critical factor in PI development (Grund et al., 2019; Hidi & Baird, 1986) and is therefore considered more important in research than PI. Within SI, a further distinction can be made between Triggered Situational Interest (TSI) and Maintained Situational Interest (MSI).

TSI is generated by environmental factors such as the learning material or a particular situation. If this interest is sustained, then MSI can develop, which enables the learner to maintain attention for a longer period of time. MSI is also created by meaningful tasks and a personal relationship with a subject (Hidi & Renninger, 2006). The Situational Interest Survey of Linnenbrinck-Garcia et al. (2010) distinguishes between TSI, MSI-feeling and MSI-value. MSI-feeling is characterised by personal value and a positive feeling for the learner, whereas MSI-value expresses the degree to which the contents are perceived as important. The questionnaire is designed for the independent measurement of SI in primary, secondary and higher education (Linnenbrinck-Garcia et al., 2010).

Research by Burnette et al. (2019) on academic performance in computer science showed a small effect that adopting a growth mindset increases learner interest and improves performance. The finding that learners with a growth mindset develop an interest in new topics is also the outcome of a number of studies on implicit theories of interest. For example, O'Keefe et al. (2018) investigates the influence of growth and fixed mindset on interest. They write that a growth mindset encourages learners to maintain their interest and deepen their understanding, even when materials become more challenging and difficult. Limited literature is available on the relationship between growth mindset, TSI, MSI-feeling and MSI-value. It is expected that TSI, MSI-feeling and MSI-value increase when learners acquire a higher growth mindset.

1.2 Present Study

As described in the theoretical framework, a lot of research has been done into growth mindset and learning in secondary and higher education. The studies show that the adoption of a growth mindset has an influence on the perceived cognitive load and learning performance of learners. Less research has been done into the effect of growth mindset on SI.

As far as known, however, no research is available into these variables within primary education. This experimental study investigates the effect of a growth mindset intervention on cognitive load, SI and learning performance of learners in grade 7 and 8 of primary school. The current study aims to investigate a growth mindset intervention on learning outcomes, cognitive load and SI. The following research questions and hypotheses will be tested in this study:

Research question 1: What is the effect of a growth mindset intervention on mindset?

- Hypothesis 1.1: Learners in the growth mindset condition will report a higher growth mindset than learners in the control condition.
- Hypothesis 1.2: Learners in the growth mindset condition will report a higher in growth mindset math than learners in the control condition.

Research question 2: What is the effect of a growth mindset intervention on experienced cognitive load?

- Hypothesis 2.1: Learners in the growth mindset condition will report a lower cognitive load than learners in the control condition.
- Hypothesis 2.2: Learners in the growth mindset condition will report a lower ICL compared to learners in the control condition.
- Hypothesis 2.3: Learners in the growth mindset condition will report a lower ECL compared to learners in the control condition
- Hypothesis 2.4: Learners in the growth mindset condition will report a lower GCL compared to learners in the control condition.

Research question 3: What is the effect of a growth mindset intervention on SI?

- Hypothesis 3.1: Learners in the growth mindset condition will report a higher SI than learners in the control condition.

- Hypothesis 3.2: Learners in the growth mindset condition will report a higher TSI than learners in the control condition.
- Hypothesis 3.3: Learners in the growth mindset condition will report a higher MSI-feeling than learners in the control condition.
- Hypothesis 3.4: Learners in the growth mindset condition will report a higher MSI-value than learners in the control condition.

Research question 4: What is the effect of a growth mindset intervention on performance?

- Hypothesis 4.1: Learners in the growth mindset condition will report higher on total performance than learners in the control condition.
- Hypothesis 4.2: Learners in the growth mindset condition will report higher on comprehension tasks than learners in the control condition.
- Hypothesis 4.3: Learners in the growth mindset condition will report higher on transfer tasks than learners in the control condition.

2. Method

In this randomised experimental, one-way between subjects design, learners were randomly assigned to the experimental or control condition to test the research hypotheses. Learners in the experimental condition were given a task that promoted growth mindset, and learners in the control condition were given a similar task that gave general information about the brain. The experimental condition was seen as the predictor. Mindset, mindset math, cognitive load, SI and learning performance were treated as the outcomes of this experimental study. Gender, grade, working memory and prior knowledge were used as variables to check the randomization over conditions. Data collection took place by means of questionnaires, reading and writing tasks.

2.1 Participants

For this study, seven schools were approached in the province of South Holland in the Netherlands. Two schools were willing to participate. The management of these schools gave their consent to conduct the study at their school. From the 149 learners from grade 7 and 8 in the age of 10 to 12 years who were approached, 108 parents gave permission for participation. Ultimately, 96 learners participated in the experiment, because some of the learners were sick at the time of the research. Each learner was randomly assigned to either the intervention or the control group. There were 49 learners in the experimental condition and 47 learners in the control condition. The average age of the learners was $M = 10.7$ with $SD = 0.64$. The minimum age was 10 years and the maximum age 12 years. From the learners, 52.1% were in grade 7 and 47.9% were in grade 8. Of the learners, 44.8% ($n = 43$) were male, and 55.2% ($n = 53$) were female.

A minimum of 210 learners was required for a minimum effect size of Cohen's $d = 0.5$, based on a power level of 95% with a 5% type I error rate. Based on a previous study of growth mindset in an experimental design (Xu et al., 2000), a minimum group size of 210 learners was required. The research could not be completed as planned, because of the measures imposed by the government due to the COVID-19 pandemic. This resulted in a strict lockdown in primary education. Because of these measures, schools did not want to participate, as no externals were allowed into the school.

2.2 Materials and Measures

To answer the research questions, a reading task, instructional video on probability, and questionnaires were used. These materials are available in Dutch and included in the appendices at the end of this research proposal.

2.2.1 Materials

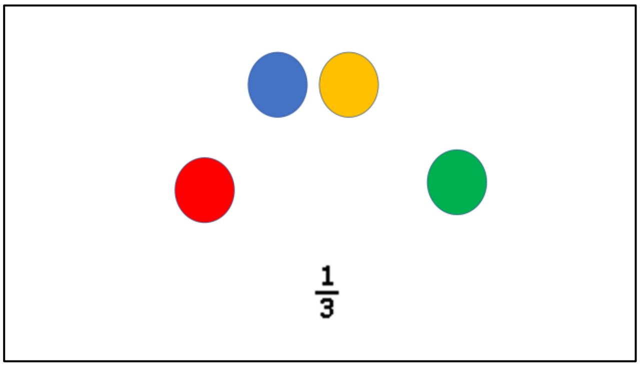
Growth mindset intervention. Learners were randomly assigned to either the intervention or the control condition. The first task was a reading and writing task (adapted from Blackwell et al., 2007; Yeager et al. 2016). The learners in the experimental condition read an article called ‘You Can Grow Your Intelligence’. Afterwards, the learners wrote a short explanation of what they had read. Yeager et al. (2019) write that a short intervention like this is suitable for providing information about growth mindset. Learners in the control condition were given a similar reading assignment about the general workings of the brain, which does not mention the malleability of the brain. In the subsequent writing assignment, the learners wrote a short summary. The summaries were analysed using words that showed that the material in both conditions were associated with learning. Words and word chuncks such as 'persist', 'keep on trying' or 'effort' were given a point. The sum of the points reflected the mindset of the learners. Learners with a higher score will rate higher in growth mindset. The material for both conditions can be found in Appendix A.

Probability instruction. Through a 7-sheet instructional PowerPoint presentation that lasted 3 minutes and 43 seconds, learners were presented the concept of solving probability problems. Since this concept of probability is not offered in the regular curriculum at primary schools, it is expected that the learners have not learned it before. The PowerPoint presentation that was viewed by the learners in the condition and control group gives an example of how a probability problem can be solved step by step. The PowerPoint presentation contained the following example: ‘The scouting staff will bring four coloured balls for the club scouts to play with. There is a red ball, a blue ball, a yellow ball, and a green ball. The club scouts may choose a ball one by one, and they have an equal preference for each colour. What is the probability that the red ball is chosen first and the green ball second?’ The material that was used is an adaptation of the material developed by

Hoogerheide et al. (2014). Figure 1 shows an example of the tasks the learners made. Additional screenshots can be found in Appendix B.

Figure 1

Slide of an example



2.2.2 Measures

Working memory. An auditory working memory test adapted from Cowan et al. (2005, 1998) to assess working memory was used. This test was recorded as an audio file which was played by computer during the experiment. Learners were presented with an increasing sequence of digits from 0 to 9, ranging from groups of 3 to 8 digits. Learners were asked to memorise the series of digits and write them down in reversed order. After each sequence, learners heard a signal tone, which indicated that they could write down the answer. Each correct answer was scored with one point. The total of points represented the span of working memory. A sum of the working memory scores was calculated. The internal reliability of this test was acceptable (Cronbach's $\alpha = .77$).

Prior knowledge. It was expected that the learners have a minimum knowledge of probability theory. Two questions were asked about adding fractions and two about subtracting fractions. To assess prior knowledge of probability, learners were given two probability tasks similar to the example in the instructional video. One point was given per good answer. The score of the four fraction exercises will reflected the prior knowledge about fractions and the score of the four probability tasks will reflected the prior knowledge about probabilities (Cronbach's α = .69). Prior knowledge of the probability exercises were assessed with tasks similar to those that the learners will take after the instruction.

Growth mindset. Growth mindset was measured with Dweck's Implicit Theory of Intelligence Scale questionnaire (in De Castella & Byrne, 2015). This questionnaire consists of four items about a growth mindset (e.g., 'I believe I have the ability to change my basic intelligence level considerably over time.') and four items about a fixed mindset (e.g. 'My intelligence is something about me that I personally can't change very much.'). For this study, learners also answered a second, adapted version, with rewritten questions related to the ability to compute probability tasks (e.g., 'I believe I have the ability to change my basic maths knowledge level considerably over time.'). The learners rated the statements using a six-point Likert scale, from 1 (*totally agree*) to 6 (*totally disagree*). The 'fixed mindset' items were scored in reverse, after which an average intelligence score were calculated for the eight items. A low score (1) stands for a complete fixed mindset, whereas a high score (6) stands for a complete growth mindset. A total score has been calculated for all items. In addition, a score has been calculated for growth mindset and growth mindset math. The regular measure (Cronbach's α = .85) and the maths-adapted measure (α = .84) both showed good internal consistency.

Cognitive Load. Cognitive load was measured with the questionnaire based on the Cognitive Load Index scale (Leppink et al., 2013). The original questionnaire related to a semester-long course, therefore the questionnaire was adapted for this study. All items were scored on a six-point likert scale from 1 (*totally agree*) to 6 (*totally disagree*). The questionnaire contained 3 questions about ICL (e.g., ‘The probability calculations in this video were a bit easy for me.’). These questions showed a good internal consistency

(Cronbach's α = .85). The questions about ECL (e.g., 'The explanation during the video about probability calculations was very easy.') showed an acceptable internal consistency (Cronbach's α = .72). Leppink et al. (2014) indicate that the questions related to the GCL theory did not reflect the exact definition. For that reason, other items were added that better fit the definition of GCL (e.g., 'I could connect the new information I learned about probability in this video with things I already knew.'). The internal consistency of these questions was acceptable (Cronbach's α = .76). For ICL, ECL and GCL, a total score was calculated by adding the items per category. In addition, a total score was calculated by adding up all items.

Situational Interest. The questionnaire used to measure SI was based on the Situational Interest Scale (adapted from Linnenbrink-Garcia et al., 2010) for measuring motivation. The scale consisted of eleven questions, 3 questions for TSI (e.g., 'The probability problems in the video are a lot of fun.'), 3 questions for MSI-feeling (e.g., 'What we learn in the probability video fascinates me.') and 4 questions for MSI-value (e.g., 'The things we learn in the probability video are useful to learn for my goals in the future.'). Items were rated on a 10-point Likert scale from 1 (*strongly disagree*) to 10 (*strongly agree*). The internal consistency of TSI (Cronbach's α = .85) and of MSI-feeling (Cronbach's α = .89) was good and of MSI-value (Cronbach's α = .76) was acceptable. For TSI, MSI-feeling and MSI-value, a total score was calculated by summing the items per category. In addition, a total score was calculated by adding up all items.

Performance. Performance was measured by means of sixteen probability problems, similar to the examples of the instruction video. Eight exercises were probability exercises, followed by a transfer problem. These exercises were presented in alternating order for each child. The tasks were similar to the example in the instruction video (adapted from Hoogerheide et al., 2014). The exercises were assessed with an answer model. One point was given for the correct answer with a maximum of 16 points for all exercises. Answers that were mathematically equal to the correct fraction were also counted correctly (e.g., 70% is also correct if 7/10th is the correct answer). The score was calculated by adding up all the points. In addition, a score was calculated for the comprehension problems and the transfer problems. The total measure showed a good internal consistency (Cronbachs $\alpha = .84$). The measure of the comprehension problems (Cronbachs $\alpha = .79$) and transfer problems (Cronbachs $\alpha = .73$) were acceptable.

2.3 Procedure

Headmasters of two primary schools were contacted by telephone and e-mail to participate in this study. Before the experiment, the parents of the learners received an information and consent letter for participation. Learners aged 12 years and older also gave their permission to participate themselves. There were seven data collection sessions in the experiment with 12 to 20 learners in each session. Every session was conducted during school time in the pupils' classroom. Learners who did not participate in the study worked on their own tasks in another room in the school, under the supervision of their own grade teacher.

Two types of envelopes were prepared for the experiment, containing the material from the experimental or control condition, and an USB stick with the PowerPoint presentation. The envelopes were randomly distributed over the participants. Each envelope was given an unique identification number afterwards, which was only used to track the experimental conditions. This identification number did not contain any information that could be traced back to a learner who used these materials.

The research was carried out in four phases taking about 75 to 90 minutes in total. Each phase was supervised by the researcher, who also ensured that the learners used the materials at the same time and spent approximately the same amount of time on a task. At the end of the study, the materials were collected by the researcher.

During the first phase, which lasted 10 minutes, learners filled in general information about their gender, grade and age. Working memory and prior knowledge were measured next. In the following phase, which lasted 20 to 30 minutes, learners in the experimental condition read an article that introduced the growth mindset, which was followed by a short writing task. Pupils in the control condition performed a similar task, which served as a control task. After that, the pupils filled in a questionnaire about the growth mindset. In the third phase, the pupils watched an instructional presentation on probability, which lasted approximately 20 minutes, and then completed the questionnaire on cognitive load and SI. Finally, in the fourth and last phase, which lasted 20 to 30 minutes, the pupils solved 16 probability problems.

After the research, the pupils and their parents received a debriefing by email from the school's headmaster. The letter contained more detailed information about the purpose and content of the study.

2.4 Data-Analysis

SPSS version 26 was used to analyze the data. Beforehand, it was checked if there were any input data, missing data, and outliers. After that, a randomization check was performed for the variables gender, grade, prior knowledge and working memory. To test the hypotheses, a one-way ANOVA was performed. A one-way ANOVA was used to compare two or more groups (Field, 2016). The independent variable was the experimental condition (i.e., intervention vs control condition). The dependent variables were mindset, mindset math, cognitive load, ICL, ECL, GCL, SI, TSI, MSI-feeling, MSI-value, performance, performance-comprehension, and performance-transfer.

3. Results

A randomization check was performed using a chi-square test to verify that the variables gender and group were equally distributed over the conditions. This test showed a significant difference for gender on condition χ^2 (1) = 4.13, *p* = .04. Furthermore, no significant difference was found for group on condition χ^2 (1) = .04, *p* = .85.

Additionally, an independent samples t-test was performed to verify that the variables prior knowledge and working memory were equally distributed over the conditions. The difference for prior knowledge on intervention condition (*M* = 5.96, *SD* = 1.76) and control condition (*M* = 5.57, *SD* = 1.68) showed no significant difference *t* (94) = 1.10, *p* = .28. Finally, the difference for working memory on intervention condition (*M* = 7.92, *SD* = 2.94) and control condition (*M* = 7.68, *SD* = 2.48) showed no significant difference *t* (94) = .43, *p* = .67. This indicates that the conditions were randomly assigned for group, prior knowledge and working memory. In addition, it appears that the conditions were not randomly distributed with regard to gender. Descriptive statistics of all variables can be found in Table 1.

Mindset *(Research question 1)*

The first hypothesis for this research was 'Learners in the growth mindset condition will report a higher growth mindset than learners in the control condition'. The intervention group reported a higher growth mindset than the control group. The difference was significant *F*(1, 94) = 21.58, *p* = .00, partial η^2 = .187.

The second hypothesis was 'Learners in the growth mindset condition will report a higher growth mindset math than learners in the control condition'. The intervention group reported higher growth mindset math than the control group. The difference was significant *F*(1, 94) = 13.57, *p* = .00, partial η^2 = .126.

Table 1

Descriptive statistics of all variables

	Experimental			Control		
	N	*M*	*SD*	*N*	*M*	*SD*
Working Memory	49	7.92	2.94	47	7.68	2.48
Prior Knowledge	49	5.96	1.76	47	5.57	1.68
Growth Mindset	49	4.73	.61	47	3.99	.93
Growth Mindset Math	49	4.74	.65	47	4.09	1.03
Cognitive Load - Total	49	3.93	.44	47	3.93	.46
Cognitive Load – ICL	49	2.45	1.00	47	2.41	1.21
Cognitive Load – ECL	49	4.59	.72	47	4.61	.93
Cognitive Load – GCL	49	4.56	.91	47	4.56	1.03
Situational Interest - Total	49	6.20	1.66	47	6.03	1.87
Triggered Situational Interest	49	5.81	1.91	47	5.64	2.31
Maintained Situational Interest -feeling	49	5.68	2.06	47	5.45	2.07
Maintained Situational Interest - value	49	7.03	1.68	47	6.89	2.04
Performance	49	11.76	3.83	47	12.04	3.41
Performance - comprehension	49	6.51	2.05	47	6.64	1.62
Performance - transfer	49	5.24	2.25	47	5.40	2.05

Research question 2: What is the effect of a growth mindset intervention on experienced cognitive load?

Cognitive Load *(Research question 2)*

The first hypothesis for this research question was ‘Learners in the growth mindset condition will report a lower cognitive load than learners in the control condition’. The difference on the total score between the intervention group and the control group was not significant $F(1, 94) = .00$, $p = .99$, partial $\eta^2 = .000$.

The second hypothesis for this research was ‘Learners in the growth mindset condition will report a lower ICL compared to learners in the control condition’. The difference between the intervention group and the control group was not significant $F(1, 94) = .03$, $p = .87$, partial $\eta^2 = .000$.

The third hypothesis for this research was ‘Learners in the growth mindset condition will report a lower ECL compared to learners in the control condition’. The difference between the intervention group and the control group was not significant $F(1, 94) = .02$, $p = .88$, partial $\eta^2 = .000$.

The fourth hypothesis for this research was ‘Learners in the growth mindset condition will report a lower GCL compared to learners in the control condition’. The difference between the intervention group and the control group was not significant $F(1, 94) = .00$, $p = .97$, partial $\eta^2 = .000$.

Situational Interest *(Research question 3)*

The first hypothesis for this research question was ‘Learners in the growth mindset condition will report a higher SI than learners in the control condition’. The difference on the total score between the intervention group and the control group was not significant $F(1, 94) = .25$, $p = .62$, partial $\eta^2 = .003$.

The second hypothesis for this question was ‘Learners in the growth mindset condition will report a higher triggered-SI than learners in the control condition’. The difference between the intervention group and the control group was not significant $F(1, 94) = .17$, $p = .68$, partial $\eta^2 = .002$.

The third hypothesis was ‘Learners in the growth mindset condition will report a higher MSI-feeling than learners in the control condition’. The difference between the intervention group and the control group was not significant $F(1, 94) = .30$, $p = .58$, partial $\eta^2 = .003$.

The fourth hypothesis for this research was ‘Learners in the growth mindset condition will report a higher MSI-value than learners in the control condition’. The difference between the intervention group and the control group was not significant $F(1, 94) = .12$, $p = .73$, partial $\eta^2 = .001$.

Performance *(Research question 4)*

The first hypothesis for this research question was ‘Learners in the growth mindset condition will report higher on total performance than learners in the control condition’. The difference on the total score between the intervention group and the control group was not significant $F(1, 94) = .15$, $p = .70$, partial $\eta^2 = .002$.

The second hypothesis was ‘Learners in the growth mindset condition will report higher on comprehension tasks than learners in the control condition’. The difference between the intervention group and the control group was not significant $F(1, 94) = .12$, $p = .74$, partial $\eta^2 = .001$.

The third hypothesis was ‘Learners in the growth mindset condition will report higher on transfer tasks than learners in the control condition’. The difference between the intervention group and the control group was not significant $F(1, 94) = .13$, $p = .72$, partial $\eta^2 = .001$.

4. Conclusion and discussion

The aim of this study was to investigate the role of a growth mindset intervention on learning of primary school learners of grade 7 and 8 and to gain more insight into the conditions for learning such as cognitive load and SI. The study examined the effects of growth mindset on cognitive load, the effect of growth mindset on SI and the effect of growth mindset on learning performance. The expectation was that learners in the intervention group would show a higher growth mindset after the intervention. It was also expected that these learners would show a lower cognitive load, a higher SI and better learning performance. The results showed that the mindset of the learners in the intervention group improved as a result of the intervention. However, the intervention did not have an effect on the cognitive load, SI and performance. The findings are elaborated per hypothesis.

Growth Mindset

The first hypothesis expected that learners in the growth mindset condition would rate higher in growth mindset than learners in the control condition. The results showed that, after the intervention, learners in the experimental condition reported higher growth mindset and growth mindset math than learners in the control condition. A further analysis showed that the effects are large. Learners in the experimental condition were given a text called 'You can grow your intelligence', which had been adapted from earlier research by Blackwell et al. (2007). When learners learn new things and step outside their comfort zone, neurons in the brain make new, stronger connections. The text in the mindset intervention provided personalised information on how to improve learning. Learners wrote sentences in the writing task such as ‘By doing your best, you will probably learn better’ or ‘If you don't get it, just do it again or ask the teacher’. The current study confirmed that knowledge about the mindset makes learners smarter and able to grow through difficulties and setbacks (Blackwell et al., 2007). Until now, there was little known about whether the mindset intervention would also have a positive effect on learners’ mindsets in grade 7 and 8 of primary education. The results of this study showed that the mindset of learners between the ages of 10 and 12 changed when they learn about a growth mindset.

Cognitive Load

The second hypothesis stated that learners in the growth mindset condition will rate lower cognitive load than learners in the control condition. In contrast to this expectation, the results showed that learners in the experimental condition did not show a significant lower cognitive load than learners in the control condition. Also, no significant differences were found on the ICL, ECL and GCL. This means that the three sub-hypotheses are rejected. These findings were not consistent with Dweck and Master (2008) who stated that learners with a growth mindset would remain engaged in learning, have a positive view of challenges within a task, show perseverance and that this would influence the extent to which the learner experiences cognitive load. These findings were in line with a recent study in secondary school learners by Xu et al. (2020), which showed that leaners in the intervention condition were more able to focus on developing knowledge and skills. In addition, they experienced less cognitive load and gained better understanding of the learning material.

These findings are probably caused by the high complexity of the task used, which is experienced as cognitively more demanding than a task with a lower level of complexity (Sweller et al., 1998). Probability problems are not part of the curriculum of grade 7 and for the learners in grade 8 it was only recently offered for the first time. It is possible that the instruction offered in this experiment did not match the instruction that the learners in grade 8 had received from their own teacher. Learners indicated that different words were used than usual. The use of different words may have required learners to think more deeply about the instruction, thereby reducing the effectiveness of the instruction and making it more demanding. Learners in the growth mindset condition may have experienced the task as too difficult due to the use of language, which may have detracted from the use of growth mindset, thus not reducing the cognitive load. Therefore, the cognitive load may not have been reduced. This is in line with Sweller (2010), who states that if information is irrelevant or ineffective, for example because the instruction is not clearly designed, the task may be perceived as difficult. It is important to design effective and efficient instruction for learners so that the different forms of cognitive load are in balance. A well-designed instruction results in a lower cognitive load for the learners (Cooper & Sweller 1987; Sweller & Cooper, 1985).

Situational Interest

In contrast to what was expected in the third hypothesis, learners in the growth mindset condition did not show a higher SI than learners in the control condition. Also, no significant differences were found in the TSI, MSI-feeling and MSI-value. O'Keefe et al. (2018) wrote that a growth mindset encourages learners to maintain their interest and deepen their understanding even when materials become more challenging and difficult. In this study, it was expected that a growth mindset would have a positive impact on SI. The result may be based on the fact that the probability tasks that the learners completed were not appealing enough or did not match the learners' world of experience. In addition, it is possible that the tasks for the learners in grade 8 were offered differently than in the regular curriculum. Hidi and Renninger (2006) write that MSI can occur with meaningful tasks and a personal relationship with the subject. During the research, a number of learners indicated that they found the research too long and that they did not find the assignments interesting. It is possible that the attitude of these students influenced the outcome of the research. However, continuing to practice can stimulate the interest of learners. If learners improve through practice and see a positive change in performance, the subject may also become more interesting, leading to greater commitment to a task.

Performance

The last hypothesis expected that learners in the growth mindset condition had higher comprehension and transfer task performance than learners in the control condition. This hypothesis is rejected because the results show that there is no significant difference between the performance of learners in the control and intervention group. There is also no significant difference between the groups for the comprehension and transfer tasks separately. Large-scale meta-studies (Bahník & Vranka, 2017; Sisk et al., 2018) of learners at the beginning of secondary school showed that growth mindset interventions have a positive but small effect on learners' learning outcomes. The results from the current study do not show this effect. It is possible that this is due to the quantity of tasks that the learners had to complete, which may have reduced the results. In addition, the tasks may not have matched the learners' experience. The transfer tasks were regularly answered too quickly by learners, without reading the question properly. This may have been caused by the length of the experiment; learners were probably less motivated at the end or the tasks were too difficult for the learners.

4.1. Limitations

This research has some limitations. The measures imposed by the government because of the COVID-19 pandemic, resulted in a strict lockdown in primary education. This meant that the research could not be completed as planned. Because of these measures, schools did not want to participate, as no externals were allowed into the school. For this study, it was calculated that a minimum of 210 learners were needed for a minimum effect size of Cohen's d = 0.5, based on a power level of 95% with a type I error of 5%. The final sample was n = 96 and was therefore too small to achieve sufficient power. Besides the fact that schools did not want to participate, there were few participants because learners were absent through illness or in quarantine at the time of the research. A second limitation is the length of this study. The research lasted between 75 and 90 minutes per class. The attitude of the learners showed that they were asked to do a lot. Several learners indicated this during the research. After a personal motivating remark, the research could be completed. A last limitation was the complexity of the task. Because learners experienced the task as difficult, their motivation and interest decreased.

4.2. Recommendations for future directions

For further research into the effect of growth mindset on learning, the study can be extended to other educational concepts such as Montessori education, Jenaplan schools or Development-oriented education. It would be interesting to investigate how learners within these educational concepts score on growth mindset. It is possible that there is a difference in the mindset of learners in other educational concepts as the education is designed in a unique way than in regular primary schools.

Recent studies combine the subject of math with research on growth mindset. In future research, the effect of growth mindset on other school subjects such as language, nature or history could be investigated. Learners may find other subjects more interesting than, for example, math. If learners are given a task that interests them personally, they may show more perseverance and be more motivated to complete the task. MSI is created by meaningful tasks and a personal relationship with a subject (Hidi & Renninger, 2006).

Another suggestion is to critically examine the length of the study. Learners regularly indicated that the research was too long and that they found the probability tasks excessive. The tension curve of learners in grades 7 and 8 is not very long.

In addition, it can be examined whether the mindset intervention can be offered in another way than on paper. The structure of the information within a task and the process of information processing by a learner determine the strain a learner experience (Paas et al., 2003). It is possible that there are other, more effective or attractive ways in which the intervention can be offered. In line with this, it could be investigated whether the study can be designed in an online program. This would make the process and reviewing easier and less time-consuming for the researcher.

4.3. Implications

The current study has contributed to existing literature and research on the effect of growth mindset on learning. Dweck & Yeager (2019) suggested that it would be interesting for future research to investigate how knowledge about growth mindset can be integrated into education. Recent research on growth mindset, cognitive load, SI, and learning has mainly taken place within secondary and higher education. Therefore, this study sought to contribute to the effect of the intervention on growth mindset on cognitive load, growth mindset on SI and growth mindset on performance among children in grades 7 and 8 of primary school.

Previous knowledge gained through research on growth mindset is increasingly being used in primary education. Teachers use this knowledge to improve the learning and motivation of their learners. Various schools use materials based on the Thinking Actively in a Social Context model (Adams & Wallace, 1991; Wallace et al., 2012) in their plus groups for children who are above average intelligent. This model also pays attention to growth mindset and the development thereof.

Current research indicates that the growth mindset increased after the intervention. However, an improvement in the growth mindset has no influence on the cognitive load, SI, and performance of learners in grade 7 and 8 in primary education when a complex learning task is used.

This does not mean that a growth mindset is not successful for learners in primary education if tasks are used that are less complex (i.e., lower cognitive load) and more appealing (i.e., higher interest). It is worthwhile conducting further research into how the growth mindset materials can be adapted to the level of learners in grade 7 and 8 of primary school. Positive findings from future research can help primary school teachers implement growth mindset interventions in the classroom to stimulate and improve learners' performance.

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Appendixes

Appendix A – Working memory test. General description audio memory span test

The learners will hear an increasing sequence of single-digit numerals ranging from 0 to 9 spoken in a male voice. The test starts with 3 digits and increases to 8 digits. Each digit lasts for about 700 ms. and is then followed by a 700 ms. pause. After each sequence is a tone that serves as a response signal. The learners are not allowed to write the digits before the signal. The learners are asked to recall 12 sequences of digits in the same way as they are read.
After a trial the following 12 sequences will be tested:

Trial
Trial1. 2 1 8
Trial2. 6 2 9
Digit Span Test
Start 3 6 4
Next 8 4 7
Next 2 6 5 8
Next 2 5 1 8
Next 7 2 8 4 0
Next 2 9 5 6 3
Next 1 6 3 8 4 5
Next 8 9 4 5 1 2
Next 3 5 8 0 6 2 1
Next 2 5 3 8 6 9 4
Next 8 5 6 4 7 3 2 1
Next 5 0 6 8 7 3 2 4

Appendix B – Prior knowledge

Table 1

Example questions prior knowledge on fractions

Los op: $\mathbf{\frac{1}{4}} + \mathbf{\frac{2}{4}}$
Los op: $\mathbf{\frac{1}{8}} + \mathbf{\frac{4}{16}} =$

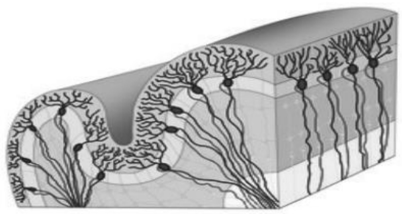
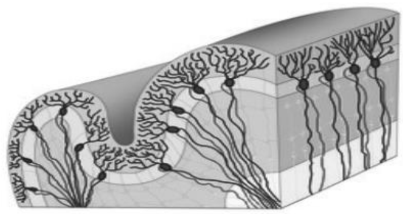
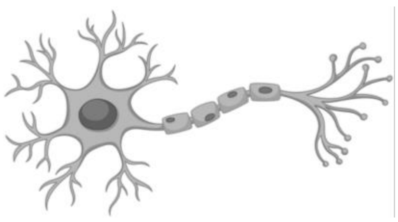
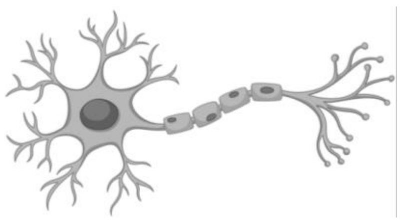
Table 2

Example question prior knowledge on probabilities

English	**Dutch**
A soccer team consisting of 11 soccer players (including Noah and Max) shoot a ball taking turns. The coach of the team decides the order in which the players can shoot. *What is the chance that Noah can shoot first, and Max can shoot second?*	Een voetbalteam dat uit 11 voetballers bestaat (waaronder Noah en Max), schiet om de beurt de bal. De coach van het voetbalteam bepaalt de volgorde waarin de voetballers mogen schieten. *Wat is de kans dat Noah als eerste en Max als tweede mag schieten?*

Appendix C – Growth mindset intervention and control task

Table 3
English and Dutch Version of the Growth Mindset Intervention (adap*ted from Blackwell et al., 2007)*

English	Dutch
You can grow your intelligence **New research showed that the brain can develop like a muscle** Many people think that the brain is a mystery. These people don't know much about intelligence and how it works. With the word intelligence, many people think that this means that you were born smart, mediocre, or stupid and that this will remain the same for your entire life. New research showed that the brain works more like a muscle that changes and becomes stronger when you use it. Scientists have been able to show how your brain grows and becomes stronger as you learn.	**Je kan je intelligentie laten groeien** **Nieuw onderzoek laat zien dat de hersenen kunnen ontwikkelen als een spier** Veel mensen denken dat de hersenen vol geheimen zitten. Deze mensen weten niet zoveel over intelligentie en hoe het werkt. Bij het woord intelligentie denken veel mensen dat dit betekent dat je slim, middelmatig of dom geboren bent en dat dit je hele leven hetzelfde blijft. Nieuw onderzoek laat zien dat hersenen meer als een spier werkt die verandert en sterker wordt wanneer je het gebruikt. Het is wetenschappers gelukt om te kunnen laten zien hoe je hersenen groeien en sterker worden als je leert.
 ***The brain*** When you learn new things, parts of the brain change and get bigger. This is just like muscles. They also change and get bigger when you exercise.	 ***De hersenen*** Wanneer je nieuwe dingen leert, veranderen er stukken van je hersens en worden ze groter. Dit werkt net zoals spieren. Die veranderen ook en worden groter als je sport.
 ***Part of the cerebral cortex*** Inside the outer layer of the brain (the cerebral cortex), there are billions of tiny nerve cells. These nerve cells make connections with other cells. These connections make it possible to thoughts and solve problems.	 ***Stuk van de hersenschil*** Binnenin de buitenste laag van de hersenen (de hersenschors) zijn er miljoenen kleine zenuwcellen. Deze zenuwcellen maken verbinding met ander cellen. De verbindingen maken het mogelijk om te denken en problemen op te lossen.
	

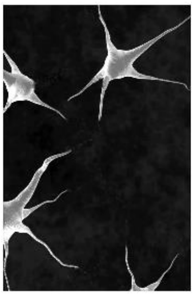
A nerve cell

How do we know that the brain can grow stronger?

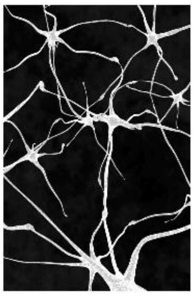
Scientists started researching animals. They thought they saw that the brain could change and develop.

They discovered that animals that lived in an environment with a lot of toys and other animals, were much more active than animals that lived in a bare cage. The animals were able to train their brains by playing with toys or other animals.

Effect of a challenging environment



Brains of animals in an empty cage.



Brains of animals that live with others and have toys.

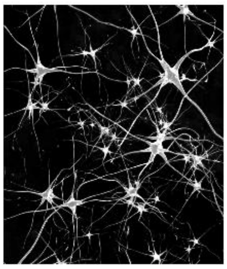
These active animals had more and stronger connections between their nerve cells in their brains. Their brains were heavier than the brains of the animals that lived in bare cages only. They were also "smarter." They were better at solving problems and learning new things.

Learning mathematics

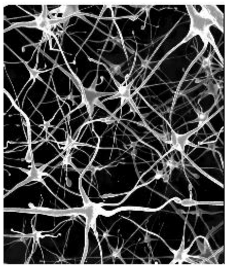
Scientists also started looking at children who learn mathematics. They found that children who practice more, and keep working on math problems, also learn more.

Once children have learned to solve a mathematics problem, they won't easily forget it. This is because their brains have changed. This happens because you learn something. The brain cells have grown and new connections have grown between the nerve cells. As a result, the brain has become stronger and smarter.

Growth of the connections between the nerve cells



At birth



At 6 years old

When you learn new things, more and more connections are added. These connections are also getting stronger. The

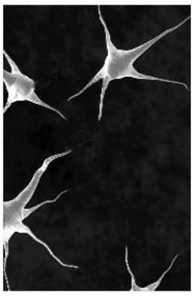
Een zenuwcel

Hoe weten we dat de hersenen sterker kunnen groeien?

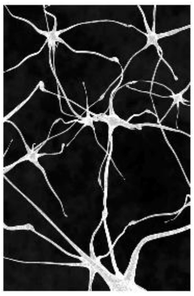
Wetenschappers begonnen met het onderzoeken van dieren. Ze dachten dat ze de hersenen konden zien veranderen en ontwikkelen.

Ze ontdekten dat dieren die in een omgeving leefden met veel speelgoed en andere dieren, veel actiever waren dan dieren die in een lege kooi leefden. Die dieren konden hun hersenen trainen door te spelen met het speelgoed of de andere dieren.

Effect van een uitdagende omgeving



Hersenen van dieren in een lege kooi.



Hersenen van dieren met speelgoed en andere dieren.

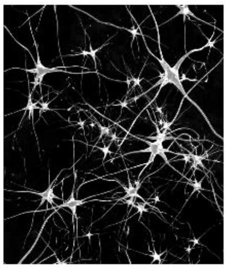
Deze actieve dieren hadden meer en sterkere verbindingen tussen de zenuwcellen in hun hersenen. Hun hersenen waren zwaarder dan de dieren die in de lege kooi leefden. Ze waren ook 'slimmer', omdat ze beter waren in het oplossen van problemen en leren van nieuwe dingen.

Leren bij rekenen

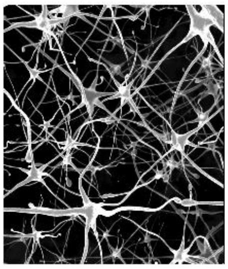
Wetenschappers begonnen ook te kijken bij kinderen die rekenen leerden. Ze vonden dat kinderen meer leerden als ze meer oefenden, en door bleven werken bij rekenoefeningen.

Wanneer kinderen geleerd hebben een rekenprobleem op te lossen, zullen ze het meestal niet zo snel meer vergeten. Dit komt omdat de hersenen veranderd zijn. Dit gebeurt omdat je iets nieuws geleerd hebt. De hersenen zijn gegroeid en er zijn nieuwe verbindingen tussen de zenuwcellen bij gekomen. Het resultaat is dat de hersenen sterker en slimmer zijn geworden.

Groei van verbindingen tussen zenuwcellen



Bij geboorte



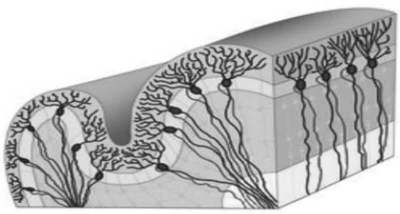
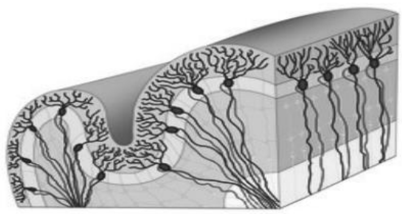
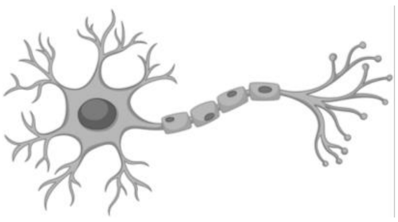
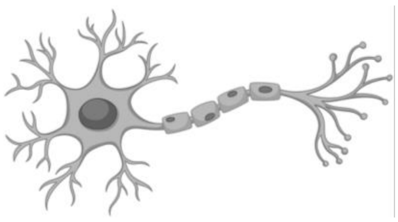
6 jaar oud

Wanneer je nieuwe dingen leert, zullen er steeds meer verbindingen bij komen. Deze verbindingen worden ook

more you challenge your brain to learn, the more your brain cells grow.	sterker. Hoe meer je de hersenen uitdaagt om te leren, hoe meer hersencellen er zullen groeien.
As a result, something you found difficult or impossible at first may suddenly seem easy. Think of things like learning to calculate math problems or a new language. The result is a stronger, smarter brain.	Het resultaat is dat iets wat je eerst moeilijk of onmogelijk vond, daarna veel makkelijker is. Je kan dan denken aan dingen zoals het uitrekenen van sommen of het leren van een nieuwe taal. Het resultaat is sterkere en slimmere hersenen.
The key to growing the brain: practice! Students who everyone thinks are "the smartest" are maybe born without being different from others. But perhaps these 'smart' students have already started practicing mathematics before going to school, for example, so that they could already build their math muscles'. Other students might perform just as well on mathematics if they practice as much.	**Het belangrijkst voor het laten groeien van je hersenen: oefenen!** Kinderen waarvan iedereen denkt dat ze 'de slimste' zijn, kunnen best geboren zijn zonder dat ze heel anders waren dan anderen. Misschien zijn deze 'slimme' kinderen bijvoorbeeld al gestart met het oefenen van lezen voordat ze naar school gingen. Ze hebben dan al aan hun 'leesspieren gewerkt. Andere kinderen kunnen misschien net zo goed leren lezen als ze evenveel oefenen.
The truth about "smart" and "stupid" Nobody thinks babies are stupid because they cannot solve math problems. They just haven't learned how to do this yet. Still, some call others stupid because they can't solve a math problem, can't spell a word correctly, or read quickly - even though all of these things can be learned through practice. The more you learn, the easier it becomes to learn new things.	**De waarheid over 'slim' en 'dom'** Niemand vindt dat baby's dom zijn omdat ze geen rekensommen kunnen oplossen. Ze hebben gewoon nog niet geleerd hoe ze dit moeten doen. Toch zijn er mensen die anderen dom noemen omdat ze geen rekensom op kunnen lossen of een woord niet goed kunnen spellen. Dit terwijl je dit kan leren door te oefenen. Hoe meer je leert, hoe makkelijker het wordt om nieuwe dingen te leren.
What can you do to get smarter? Just like an athlete, you will have to train and practice. When you exercise you make your brain stronger. You will also learn skills that allow you to use your brain more smartly.	**Wat kan je doen om slimmer te worden?** Net als een sporter, zal je moeten trainen en oefenen. Wanneer je oefent maak je je hersenen sterker. Je zult ook dingen leren die je helpen om je hersenen beter te gebruiken.
However, many people miss the opportunity to grow their brains more strongly, because they think they cannot, or because it is too difficult. It takes effort, but if you feel yourself getting stronger and better, it's worth it!	Alleen lopen heel veel mensen de kans mis om hun hersenen sterker te maken, omdat ze denken dat ze het niet kunnen of dat het moeilijk is. Het koste moeite, maar als je je hersenen sterker en beter voelt worden, is dat het waard!
Read and carry out the exercise below: You have probably experienced that you found a subject difficult to learn, but that you succeeded after a lot of practice and hard work. You can think of, for example, solving math problems.	*Lees en maak de opdracht hieronder:* Je hebt waarschijnlijk wel eens meegemaakt dat je iets eerst moeilijk vond, maar dat het na veel oefenen, moeite doen en hard werken toch gelukt is. Je kan dan bijvoorbeeld denken aan het oplossen van rekensommen.
What if there was a classmate that thinks a subject is very hard and he/she doesn't know what to do anymore.	Stel: er is een klasgenoot die iets heel moeilijk vindt en diegene weet niet meer wat hij of zij moet doen.
What would you like to tell him/her? What would you like to say to the person to help him or her? Write that down below:	Wat zou je hem of haar willen vertellen? Wat zou je tegen die persooon zeggen om hem of haar te helpen? Schrijf dat hieronder op.

Table 4

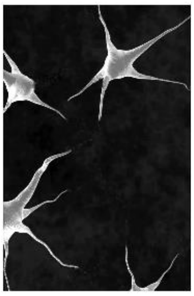
English and Dutch Version of the Control Task.

English	Dutch
The brain is the computer in your head **Through research, we know a lot about the different parts of the brain**.	**De hersenen zijn de computer in je hoofd.** **Door onderzoek weten we al veel over de verschillende onderdelen van de hersenen.**
The brains of humans and animals can be compared to a computer. They regulate everything in your body and you can't do without it. For example, your brain ensures that you don't forget to breathe, remember things, laugh. In short, everything that ensures that you can live.	De hersenen van mensen en dieren zijn te vergelijken met een computer. Ze regelen werkelijk alles in je lichaam. Je hersenen zorgen er bijvoorbeeld voor dat je niet vergeet adem te halen en dat je dingen kunt onthouden. Kortom, alles wat ervoor zorgt dat je kan leven.
In recent years, scientific research has increasingly shown how the brain works. Our brain is very complicated and consists of many brain cells. The number of cells in our brain is comparable to the number of stars in the universe.	Onderzoek heeft de afgelopen jaren zien hoe de hersenen werken. Onze hersenen bestaan uit heel veel hersencellen. De hoeveelheid cellen in onze hersenen is vergelijkbaar met het aantal sterren in het heelal.
	
The brain	**De hersenen**
In addition to all cells, there are many connections. It performs very simple, but also difficult tasks. From grabbing a cup of coffee to making plans for the future.	Naast alle cellen zijn er heel veel verbindingen. Daar worden simpele en moeilijke taken mee uitgevoerd. Zoals het pakken van een kopje koffie, tot aan het maken van plannen voor de toekomst.
	
Cerebral bark	**De buitenste laag van de hersenen**
Parts of the brain The brain consists of three parts. The first part is the brain stem. This ensures that your heart works, that you can breathe, and that your blood continues to flow. This is all automatic. For example, you never have to think about making your heart beat.	**Delen van de hersenen** De hersenen bestaan uit drie onderdelen. Het eerste onderdeel is de hersenstam. Die zorgt ervoor dat je hart werkt, dat je adem kan halen en dat je bloed blijft stromen. Dit gaat allemaal automatisch. Je hoeft er bijvoorbeeld nooit over na te denken dat je je hart weer een keer laat kloppen.
	

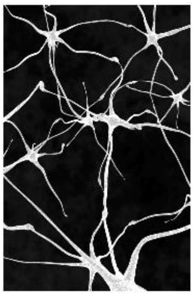
A nerve cell
The second part is the cerebellum. They keep your body moving all day long. Your brain also remembers how to swim, cycle, and walk, for example. You hardly have to think about what you are doing with these things.

The third part is the cerebrum. These consist of two halves: the left and right brain hemispheres. The funny thing about this is that your left hemisphere controls the right side of your body and the right hemisphere controls the left side.

Brain cells



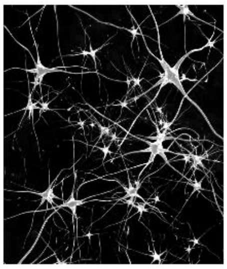
Picture of brain cell in babies

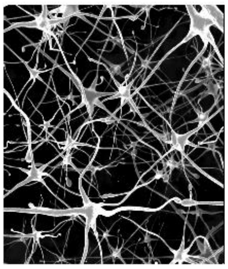


Picture of brain cell in animals.

Lobes
The hemispheres of the brain consist of loose pieces. We call these pieces lobes. Each hemisphere has four lobes: the forehead lobe allows you to make decisions, become angry or happy, or make plans. The parietal lobe ensures that you can read, calculate, feel, smell, and taste. The occipital lobe ensures that you can look, move, and recognize things. The sleeping lobe ensures that you understand language, can hear, remember things, and can concentrate.

The nervous system
Brains are made up of nerve cells. These are very small particles of your body that you can only see with a microscope. Nerve cells are not only in your head but throughout your body. These nerve cells together are called the central nervous system.





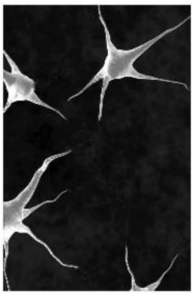
Connections between brain cells

Nerve cells are like small phones. They pass on all kinds of messages to each other. When you handle a hot pan incorrectly, nerve cells work very quickly. They then give a

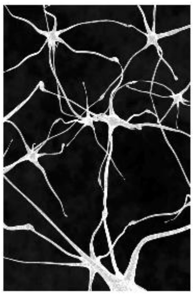
Een zenuwcel
Het tweede deel zijn de kleine hersenen. Die laten je lichaam de hele dag door bewegen. Ook onthouden je kleine hersenen hoe je bijvoorbeeld moet zwemmen, fietsen en lopen. Je hoeft bij deze dingen bijna niet na te denken wat je doet.

Het derde deel zijn de grote hersenen. Deze bestaan uit twee helften: de linker- en rechterhersenhelft. Door de grote hersenen kan je bijvoorbeeld denken, horen en kijken. Maar dat moet je zelf besturen en gaat niet automatisch, zoals in de kleine hersenen.

Hersencellen



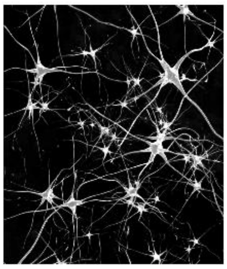
Hersencellen bij Baby’s

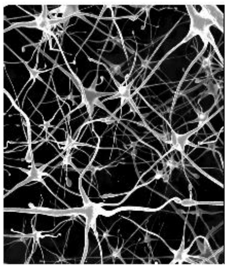


Hersencellen bij dieren

Kwabben
De hersenhelften bestaan uit losse stukken. Die stukken noemen we kwabben. Elke hersenhelft heeft vier kwabben: de voorhoofdkwab zorgt ervoor dat je beslissingen kan nemen, boos of blij kan worden of kan plannen. De wandbeenkwab zorgt ervoor dat je kunt lezen, rekenen, voelen, ruiken en proeven. De achterhoofdkwab zorgt ervoor dat je kunt kijken, bewegen en dingen kunt herkennen. De slaapkwab zorgt ervoor dat je taal begrijpt, kan horen, dingen kunt onthouden en je kunt concentreren.

Het zenuwstelsel
Hersenen bestaan uit zenuwcellen. Dat zijn hele kleine deeltjes van je lichaam, die je alleen met een microscoop kan zien. Zenuwcellen zitten niet alleen in je hoofd, maar door je hele lichaam. Deze zenuwcellen samen heten het centrale zenuwstelsel.





Verbindingen tussen de hersencellen

Zenuwcellen zijn eigenlijk een soort kleine telefoontjes. Ze geven allerlei boodschappen aan elkaar door. Als je een hete pan verkeerd vastpakt werken zenuwcellen heel snel.

message to your hand by letting go right away! We call such a rapid response a reflex.	Ze geven dan een boodschap aan je hand door op meteen los te laten! Zo’n snelle reactie noemen we een reflex.
As you read this, your heart is beating, you're breathing, and you're blinking now and then. All brain work. This is also done by nerve cells. You have 100 billion of them. They transmit stimuli from your brain to your little toe and back. The stimuli consist of small streams and chemical substances. These are also called neurotransmitters.	Terwijl je dit leest, klopt je hart, haal je adem en knipper je af en toe met je ogen. Allemaal hersenwerk. Dat wordt ook gedaan door zenuwcellen. Je hebt er 100 miljard van. Ze geven prikkels door van je hersenen naar je kleine teen en weer terug. De prikkels bestaan uit kleine stroompjes en chemische stofjes. Deze worden ook wel neurotransmitters genoemd.
Memory	**Geheugen**
Some nerve cells specialize in smelling or tasting. Others are more for when you feel pain. Some form your thoughts. You can give other nerve cells commands by thinking, for example, to move your leg. A large portion of your nerve cells go to great lengths to remember things. Together they form your memory.	Sommige zenuwcellen zijn gespecialiseerd in ruiken of proeven. Andere zijn er meer voor als je pijn voelt. Sommige vormen je gedachten. Andere zenuwcellen kan je door te denken opdrachten geven, bijvoorbeeld om je been te bewegen. Een groot gedeelte van je zenuwcellen doen veel moeite om dingen te onthouden. Ze vormen samen je geheugen.
Your memory is divided into a kind of boxes. It is a kind of library. The better you organize this library, the better your memory works.	Je geheugen is opgedeeld in een soort vakjes. Je geheugen lijkt op een soort bibliotheek. Hoe beter je deze bibliotheek indeelt, hoe beter je geheugen werkt.
Brain research	**Hersenonderzoek**
They used to be able to view brains only if someone had died. Fortunately, that is no longer necessary and we can scan the brain. Using devices, doctors can look at pictures of the brain and conduct research.	Vroeger konden ze hersenen alleen maar bekijken als iemand dood was gegaan. Gelukkig hoeft dat nu niet meer en kunnen we hersenen scannen. Met gebruik van apparaten kunnen dokters kijken naar foto’s van de hersenen en zo onderzoek doen.
By researching the brain, we have already learned many things. However, we still do not know everything and there is, therefore, plenty that scientists can still research. Hopefully, we will learn more about that big computer in our heads soon.	Door onderzoek naar de hersenen te doen zijn we al veel dingen te weten gekomen. Toch weten we nog lang niet alles en is er dus genoeg waar wetenschappers nog onderzoek naar kunnen doen. Hopelijk komen we dus snel nog meer te weten over die grote computer in ons hoofd!
Read and carry out the exercise below: You read a text with a lot of information on the brain.	*Lees en maak de opdracht hieronder:* Je hebt een tekst gelezen met veel informatie over de hersenen.
Write a short summery to one of your classmates that explains what you’ve read.	Schrijf een korte tekst aan één van je klasgenoten waarin je uitlegt wat je allemaal gelezen hebt.
What would you like to tell your classmate? Write it down below:	Wat zou je jouw klasgenoot willen vertellen? Schrijf dat hieronder op:

Appendix D – Learning task

Figure 2

Example screenshot (slide 1)

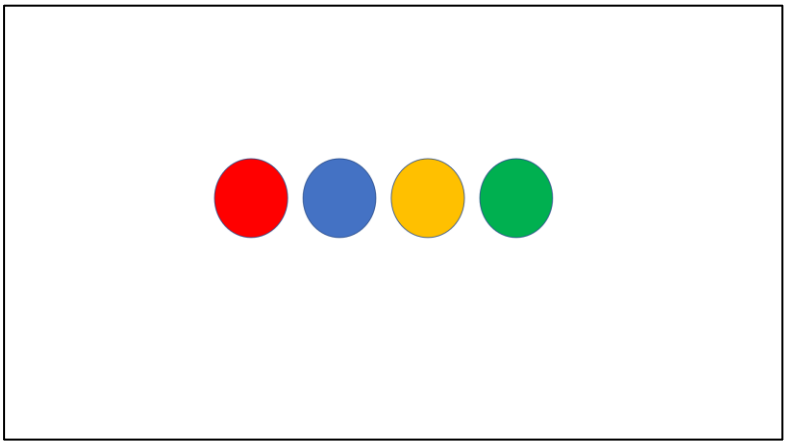


Figure 3

Example screenshot (slide 2)

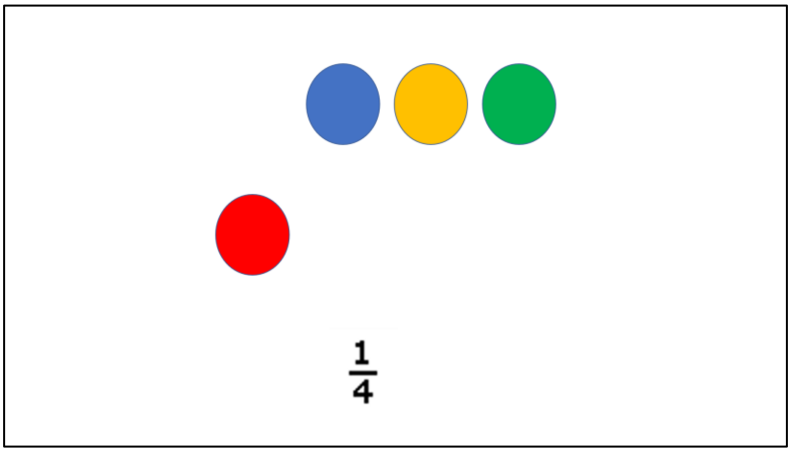
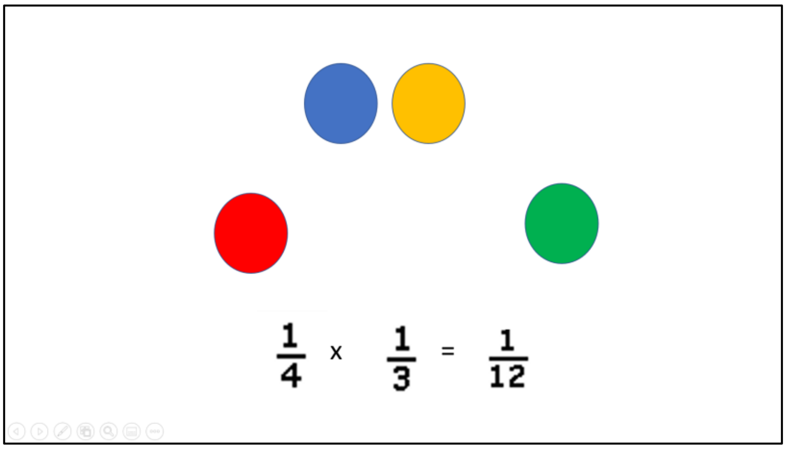


Figure 4

Example screenshot (slide 4)



Appendix E – Growth Mindset

Table 5

Revised Implicit Theory of Intelligence (Self Theory) Scale (De Castella & Byrne, 2015)

English	**Dutch**
I don't think I personally can do much to increase my intelligence.	Ik denk dat ik persoonlijk niet veel kan doen om mijn intelligentie te laten toenemen.
My intelligence is something about me that I personally can't change very much.	Mijn intelligentie is iets over mij wat ik persoonlijk niet erg kan veranderen.
To be honest, I don't think I can really change how intelligent I am.	Om eerlijk te zijn, denk ik niet dat ik echt kan veranderen hoe intelligent ik ben.
I can learn new things, but I don't have the ability to change my basic intelligence.	Ik kan nieuwe dingen leren, maar ik kan mijn basisintelligentie niet veranderen.
With enough time and effort, I think I could significantly improve my intelligence level.	Met genoeg tijd en moeite, denk ik dat ik mijn intelligentie heel erg kan verbeteren.
I believe I can always substantially improve on my intelligence.	Ik denk dat ik mijn intelligentie altijd heel erg kan verbeteren.
Regardless of my current intelligence level, I think I have the capacity to change it quite a bit.	Het maakt niet uit wat mijn intelligentieniveau nu is, ik denk dat ik de mogelijkheid heb om het best wel te veranderen.
I believe I have the ability to change my basic intelligence level considerably over time.	Ik denk dat ik de mogelijkheid heb om mijn basisintelligentie in de loop van de tijd heel erg te veranderen.

Table 6

Revised Implicit Theory of Intelligence (Self Theory) Scale - Adapted (adapted from De Castella & Byrne, 2015)

English	**Dutch**
I don't think I personally can do much to increase my maths knowledge.	Ik denk dat ik niet veel kan doen om mijn kennis over rekenen te laten toenemen.
My maths knowledge is something about me that I personally can't change very much.	Wat ik weet over rekenen is iets over mij dat ik persoonlijk niet erg kan veranderen.
To be honest, I don't think I can really change my maths knowledge.	Om eerlijk te zijn, denk ik niet dat ik wat ik weet over rekenen echt kan veranderen.
I can learn new things, but I don't have the ability to change my basic knowledge of maths.	Ik kan nieuwe dingen leren, maar ik kan mijn basiskennis over rekenen niet veranderen.
With enough time and effort, I think I could significantly improve my maths knowledge.	Met genoeg tijd en moeite, denk ik dat ik mijn rekenkennis heel erg kan verbeteren.
I believe I can always substantially improve on my maths knowledge.	Ik denk dat ik mijn rekenkennis altijd heel erg kan verbeteren.
Regardless of my current maths knowledge, I think I have the capacity to change it quite a bit.	Het maakt niet uit wat ik nu over rekenen weet, ik denk dat ik de mogelijkheid heb om het heel erg te veranderen.
I believe I have the ability to change my basic maths knowledge level considerably over time.	Ik denk dat ik de mogelijkheid heb om basiskennis over rekenen in de loop van de tijd heel erg te veranderen.

Appendix F – Cognitive load

Table 7

Cognitive Load Index - Adapted (adapted from Leppink e.a., 2013)

English	**Dutch**
The topic covered in this probability video was… *Not at all complex / very complex*	Het onderwerp in deze video over kansberekening was… *Helemaal niet moeilijk / heel erg moeilijk*
The examples of probability calculations in this video were for me..... *Not at all complex / very complex*	De voorbeelden van kansberekeningen in deze video waren voor mij… *Helemaal niet moeilijk / heel erg moeilijk*
I found the topics and words in this video about probability... *Not at all complex / very complex*	De onderwerpen en woorden in deze video over kansberekening vond ik… *Helemaal niet moeilijk / heel erg moeilijk*
The instructions or explanations during the probability video were … *Not at all clear / very clear*	De uitleg tijdens de video over kansberekening was… *Helemaal niet duidelijk / heel erg duidelijk*
The instructions and/or explanations during the probability video were, in terms of learning… *Not at all effective / Very effective*	De uitleg tijdens de video over kansberekening werkten voor mijn leren… *Helemaal niet goed/heel erg goed*
The instructions and/or explanations during the probability video were, full of… *Very unclear language / very clear language*	De uitleg van de video over kansberekening zal vol met… *Heel erg onduidelijke taal/heel erg duidelijke taal*
I could fully understand the concepts covered in the probability video. *Not at all the case / completely the case*	Ik kon de onderwerpen in de video over kansberekening volledig begrijpen *dat is helemaal niet zo /dat is helemaal wel zo*
I could make sense of most of the ideas presented in the probability video. *Not at all the case / completely the case*	Ik kon de meeste ideeën in de video over kansberekeningen begrijpen. *dat is helemaal niet zo / dat is helemaal wel zo*
I could see how all elements described in the probability video are interconnected *Not at all the case / completely the case*	Ik kon zien hoe alle onderdelen die werden beschreven in de video over kansberekening met elkaar te maken hadden. *dat is helemaal niet zo / dat is helemaal wel zo*
I could connect the new information I learnt in this probability video to what I already knew about the topic *Not at all the case / completely the case*	Ik kon de nieuwe informatie die ik in deze video over kansberekening geleerd heb verbinden aan dingen die ik al wist. *dat is helemaal niet zo / dat is helemaal wel zo*

Appendix G – Situational Interest

Table 8

Situational Interest questionnaire - Adapted (adapted from Linnenbrink-Garcia e.a., 2010)

English	Dutch
The probability problems in the video are a lot of fun. *1 2 3 4 5 6 7 8 9 10*	De kansberekeningsproblemen in de video zijn heel erg leuk. *1 2 3 4 5 6 7 8 9 10*
In the probability video, the teacher explains things that interest me. *1 2 3 4 5 6 7 8 9 10*	In de kansberekeningsvideo legt de leraar dingen uit die mij interesseren. *1 2 3 4 5 6 7 8 9 10*
The probability video is fun to watch. *1 2 3 4 5 6 7 8 9 10*	De kansberekeningsvideo is leuk om naar te kijken. *1 2 3 4 5 6 7 8 9 10*
The probability problems are so much fun that it is easy to keep your attention. *1 2 3 4 5 6 7 8 9 10*	De kansberekeningsproblemen zijn zo leuk dat het makkelijk is om je aandacht erbij te houden. *1 2 3 4 5 6 7 8 9 10*
What we learn in the probability video fascinates me. *1 2 3 4 5 6 7 8 9 10*	Wat we leren in de kansberekeningsvideo fascineert me. *1 2 3 4 5 6 7 8 9 10*
I love what we learn in the probability video. *1 2 3 4 5 6 7 8 9 10*	Ik vind het geweldig wat we leren in de kansberekeningsvideo. *1 2 3 4 5 6 7 8 9 10*
I like what we learn in the probability video. *1 2 3 4 5 6 7 8 9 10*	Ik vind het leuk wat we leren in de kansberekeningsvideo. *1 2 3 4 5 6 7 8 9 10*
I find the calculations in the probability video interesting. *1 2 3 4 5 6 7 8 9 10*	Ik vind het rekenen in de kansberekeningsvideo interessant. *1 2 3 4 5 6 7 8 9 10*
What we learn in the probability video is nutting for me to know. *1 2 3 4 5 6 7 8 9 10*	Wat we leren in de kansberekeningsvideo is nuttig om te weten voor mij. *1 2 3 4 5 6 7 8 9 10*
The things we learn in the probability video are useful to learn for my goals in the future. *1 2 3 4 5 6 7 8 9 10*	De dingen die we leren in de kansberekeningsvideo zijn nuttig om te leren voor mijn doelen in de toekomst. *1 2 3 4 5 6 7 8 9 10*
What we learn in the probability video can be applied to real life. *1 2 3 4 5 6 7 8 9 10*	Wat we leren in de kansberekeningsvideo kan je toepassen in het echte leven. *1 2 3 4 5 6 7 8 9 10*

Appendix H – Performance task

Table 9

Performance task examples probability items

English	Dutch
During a story contest in the classroom, 11 children, including Hans and iris, are allowed to tell a story to the class. The teacher decides the order in which the children may tell their stories. a. What is the probability that Hans gets to tell the story first? b. What is the probability that Iris gets to tell the story second?	Tijdens een verhalenwedstrijd in de klas mogen 11 kinderen, waaronder Hans en iris, aan de klas een verhaal vertellen. De leerkracht bepaalt de volgorde waarin de kinderen mogen vertellen. a. Wat is de kans dat Hans als eerste mag vertellen? b. Wat is de kans dat Iris als tweede mag vertellen?
On Pet Day, grasshoppers jump as far as they can during a competition. A total of 6 grasshoppers are jumping and their names are: Jaap, Eva, Sofie, Tamara, Fred and Remy. You have no information about which grasshopper can jump the furthest. a. What is the probability that Eva is first. b. What is the probability that Fred finishes second?	Op dierendag springen sprinkhanen zo ver als ze kunnen tijdens een wedstrijd. In totaal zijn er 6 sprinkhanen die mee springen en hun namen zijn: Jaap, Eva, Sofie, Tamara, Fred en Remy. Je hebt geen informatie over welke sprinkhaan het verst kan springen. a. Hoe groot is de kans dat Eva eerste. b. Hoe groot is de kans dat Fred als tweede eindigt?