MASTER'S THESIS

The Effect of Fostering a Growth Mindset on Interest, Perceived Cognitive Load, and Performance: Does Intervention Strategy Matter?

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Het Effect van het Bevorderen van een Groei Mindset op Interesse, Ervaren Cognitieve Belasting en Prestatie: Doet de Interventiestrategie Ertoe?

The Effect of Fostering a Growth Mindset on Interest, Perceived Cognitive Load, and Performance: Does Intervention Strategy Matter?

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Samenvatting

De huidige studie was bedoeld om inzicht te geven in het effect van het bevorderen van een growth mindset op situationele interesse, cognitive load en leerprestaties. Twee interventiestrategieën kwamen aan bod; een growth mindset lees- en schrijfopdracht over de plasticiteit van het brein en een compliment gericht op inzet. Een steekproef van 161 Nederlandse basisschoolkinderen in groep 7 en 8 nam deel aan een gerandomiseerd experimenteel 2 x 2 ontwerp. Mindset-overtuiging, situationele interesse en cognitive load werden gemeten aan de hand van zelfbeoordeling op vragenlijsten. Voorkennis en leerprestaties werden gemeten met scores op kansberekeningsproblemen. Voorkennis werd tevens opgenomen als een covariaat. Deze studie bevestigde dat een groeimindset lees- en schrijfinterventie over de plasticiteit van het brein zorgde voor een hogere growth mindset overtuiging. Bovenal was er een significant interactie-effect voor het combineren van beide interventies op leerprestaties. Hoewel de veronderstelde effecten op interesse en cognitive load niet volledig konden worden bevestigd zijn de resultaten veelbelovend en moedigen verder onderzoek aan om bij te dragen aan de ontwikkeling van effectieve growth mindsetinterventieprogramma's om het leerproces te optimaliseren en studenten te motiveren.

Keywords: Growth Mindset Interventie, Situationele Interesse, Cognitive Load, Leerprestatie

Abstract

The present study aimed to give insights in the effect of fostering a growth mindset on situational interest, perceived cognitive load, and learning performance. Two intervention strategies were addressed; a growth mindset reading text and writing assignment about the malleability of the brain and a praise for effort strategy. A sample of 161 Dutch primary school children in the 7th and 8th grade participated in a randomized experimental 2 x 2 design. Mindset belief, situational interest and cognitive load were measured by subject ratings on questionnaire items. Prior knowledge and learning performance were measured with scores on probability problem calculations. Prior knowledge was included as a covariate. This study confirmed that a growth mindset reading and writing intervention about the malleability of the brain, ensured a higher growth mindset belief. Foremost there was a significant interaction effect for combining a growth mindset reading and writing intervention and a praise for effort intervention on learning performance. Although the assumed effects on interest and perceived cognitive load could not be fully confirmed, the results are promising and encourage further research to contribute to the development of effective growth mindset intervention programmes to optimize the learning process and motivate students.

Keywords: Growth Mindset Intervention, Situational Interest, Cognitive Load, Learning Performance

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1. Introduction

From the perspective of growth mindset theory (Dweck & Leggett, 1988; Dweck, 2000), students hold different beliefs about their intelligence and abilities. Some believe that their intelligence and abilities are unchangeable, regardless of the effort expended or strategy employed (fixed mindset), others think of intelligence and abilities as a malleable quality that can be developed through hard work, good strategies, and support from others (growth mindset). The mindset students have regarding their intelligence and ability, impacts their motivation, engagement, and learning results (Blackwell et al., 2007; Xu et al., 2020; Yeager et al., 2019).

Fostering a growth mindset could therefore be beneficial in order to increase learner motivation and improve learning (Dweck & Yeager, 2019). This seems necessary because unfortunately, students are not always motivated for their schoolwork. Research shows that the motivation of Dutch primary school students internationally is lagging behind (OECD, 2016): both in the field of reading (Gubbels et al., 2017) and in the field of math (Meelissen & Punter, 2016) there is a lack of motivation and parallel declining performance over de last 15 years (Inspectie van het Onderwijs, 2020).

According to Renninger and Hidi (2016**)** the cultivation of motivation, such as interest is an important component of the learning process. Interest is crucial for initiation and persisting in learning, deepens learning and improves performance (Renninger & Hidi, 2016, 2020). Interest is conceptualized as a content-specific motivational variable that can inform us about why students are motivated to engage and to learn specific subject matter (Hidi, 2000). Fostering a growth mindset seems to increase value-related aspects towards a task and may be an effective way to cultivate learners' interest (Burnette et al., 2019; Xu et al., in press).

In addition, experienced cognitive load is assumed to interact with the motivational aspects of learning (Feldon et al., 2019; Plass & Kalyuga, 2019, Xu et al., 2020). Cognitive load refers to the load of the information process induced by learning tasks. Students with a growth mindset tend to have a lowered perception of cognitive load (Cook et al., 2017; Xu et al., 2020).

There is still a gap in knowledge about how a growth mindset influences motivation and cognitive factors during the learning processes, especially in primary school students. Most research currently done focusses on secondary school and higher education students (e.g., Savvides & Bond, 2021; Sisk et al., 2018). However, understanding the interplay between cognitive load and motivational beliefs such as growth mindset and interest may be especially important for primary school students since these younger students are still at the beginning of their school career, thus motivation intervention programmes might be particularly effective for them.

Looking at this target group, two intervention strategies seem promising. First, a growth mindset reading and writing intervention about the malleability of the brain (Blackwell et al., 2007; Yeager et al., 2016). Secondly, a praise for effort intervention (Mueller & Dweck, 1998). Both interventions have shown to be effective strategies to foster a growth mindset. In previous studies there were significant differences between the intervention and control groups for a praise for effort intervention (Mueller & Dweck, 1998) and $F = 3.98$, $p < .05$ for a growth mindset reading and writing intervention about the malleability of the brain (Blackwell et al., 2007). To date, no previous research has done on the effect of both strategies in comparison. In the present research both interventions strategies were examined in Dutch primary school children on grades 7 and 8 in a randomized experimental 2 x 2 design in order to investigate the effect of fostering a growth mindset on interest, perceived cognitive load, and learning performance.

1.1 Theoretical Framework

1.1.1 Growth Mindset

A growth mindset is the belief that intelligence and abilities are malleable qualities that can be developed. A fixed mindset at the opposite is the belief that these qualities are fixed (Dweck & Leggett, 1988; Dweck, 2000). The mindset theory gives a framework on how mindsets predict the choice of different attributions in the face of failure, and the helpless versus mastery-oriented responses to failure (Dweck, 2017). Students with growth, relative to fixed, mindsets report valuing learning more (Dweck, 2000), focus more on learning goals that aimed at increasing their ability (Blackwell et al., 2007; Dweck & Leggett, 1988), believe in the utility of effort and hold more positive beliefs about effort, (Blackwell et al., 2007; Hong et al., 1999).

Research has shown that, even when students on both ends of the mindset continuum show equal intellectual ability, their mindset belief shape their responses to academic challenge (Blackwell et al., 2007). The belief that only the ability itself brings success and you don't need the effort anymore can be disadvantage, because when the curriculum becomes challenging, these students might drop out (Dweck, 2007).

1.1.2. Growth Mindset Interventions

Research has indicated that mindsets could be changed through growth mindset interventions (Blackwell et al., 2007; Paunesku et al., 2015; Yeager et al., 2019; Xu et al., 2020). Most growth mindset interventions focus on cultivating the belief that students' general intellectual ability can be developed in order to increase learner motivation and improve learning (Yeager & Dweck, 2012).

For example a growth mindset reading and writing intervention has been successfully used in previous studies (Aronson et al., 2002; Blackwell et al., 2007; Yeager et al., 2016,

2019; Paunesku et al., 2015; Xu et al., 2020). This intervention consists of a scientific article that teaches about the malleability of the brain and use the metaphor that the brain is like a 'muscle' that gets stronger with exercise (Aronson et al., 2002). The scientific article tries to persuade the students of the idea that learning something new is a result of effort and practice. In order to convince students even more of this idea, they are asked to write a letter of a few sentences with advice to a classmate who is struggling with a subject that's hard for him. Recent research of Xu et al. (2020) shows that such a growth mindset intervention leads to a higher growth mindset belief.

However, there are several controversies about mindset interventions (Yeager & Dweck, 2020). In their meta-analyse Sisk et al. (2018) argued that the effect sizes for interventions on academic achievement are too small to be meaningful (study 2) and they found a very weak correlation between mindset and academic achievement (r = .10) (study 1). Besides, most research is conducted with adolescents. Just a few experimental studies have been done on the effect of growth mindset interventions with primary school students (Savvides & Bond, 2021).

1.1.3 Growth Mindset Intervention in Children: Praising for Effort as an Intervention Strategy

Mindsets can arise from messages we get from others. Growth mindset studies with children below the age of 12 mainly focus on intervention strategies based on parental or teacher influences via person praise (praise for intelligence) versus performance praise (praise for effort) (Andersen & Nielsen, 2016; Li & Bates, 2019; Mueller & Dweck, 1998; Pomerantz & Kempner, 2013; Seaton, 2018). For example Mueller and Dweck (1998) reported six studies on children aged 9–12 years old, and found that praise for intelligence created a fixed mindset whereas praise for effort tended to put children in a growth mindset. In study 1, 3, 5 and 6 (n = 128, 88, 46, and 48, respectively), mindset was manipulated by giving different

forms of praise after working on a task. All children received a task score of 80%, no matter their actually performance, and the teacher praised them for their intelligence: “You must be smart at these problems” or for their effort: “You must have worked hard at these problems”. Children in the control condition received no additional feedback. Then, children worked on a more difficult task and all received a score of 50%. After this setback, children who received praise for intelligence showed more negative responses such as, less task persistence, less task enjoyment, worse performance, and were more likely to attribute their failure to a lack of ability compared to those who received praise for effort. In study 4 and 6 (n = 51 and 48), the influence of praise for intelligence and praise for effort on children's beliefs about the nature of intelligence was investigated. Children who were praised for intelligence after working successfully on a task agreed more with statements that described intelligence as fixed e.g.,: “Your intelligence is something basic about you that you can't really change”. On the other hand, children who were praised for effort after success defined the nature of intelligence more in terms of an ability that’s malleable i.e., growth mindset.

Recently Li and Bates (2019) conducted three replication studies (study 1, 2 and 3; n = 190, 222 and 211 respectively) on one of the Mueller and Dweck (1998) studies (study 1) but found that beliefs about the malleability of basic ability may not be related to resilience to failure or progress in school. However, according to Yeager and Dweck (2020), each Li and Bates study (2019) was under-powered, and when aggregate the data to increase the statistical power Yeager and Dweck (2020) did find a confirmation of the results of the Mueller and Dweck (1998) study. Thereby, the ethnicity (Chinees) of the participants in the Li and Bates (2019) study differs of the ethnicity (European-American 50%, African-American 19% and Hispanic 31%) of the Mueller and Dweck (1998) participants. Looking at the PISA data (OECD, 2019) there is no positive correlation between mindset and reading scores for Chinese students. While Across OECD countries, on average, students with a growth mindset

score 32 points higher in reading than students with a fixed mindset, the Hong Kong students scored 3 points and Beijing, Shanghai, Jiangsu and Zhejiang students scored -9 points. Students in the Netherlands scored 16 points and US students scored 58 points. This may suggest that the Li and Bates study (2019) was conducted in a cultural context that have a weakest link between mindsets and achievement.

More research seems to be necessary, Savvides and Bond (2021) suggest in their meta-analyse that the focus on a growth mindset element, such as process praise, would be a good foundation for further effectiveness trials in primary school settings. Nevertheless Dweck and Yeager (2020, p. 1277) emphasize that for the effectiveness of a growth mindset intervention "it must make an argument that ability itself has the potential to be developed". A definition alone cannot motivate behaviour change and just telling students that they succeeded because they tried hard doesn't either. This is an indication that intervention strategies only based on praise for effort may not fully transmit the actual concept of growth mindset. Therefore, in the current study a combined intervention consisting of a scientific reading text and writing assignment about the malleability of the brain and praise for effort was used as a growth mindset intervention in order to foster motivational variables, such as interest.

1.1.4 Interest

Interest is conceptualized as a content-specific motivational variable that can inform us about why students are motivated to engage and to learn specific subject matter (Hidi, 2000). Interest energizes learning, guides academic and career trajectories, and is essential to academic success. According to Schunk et al. (2010) interest as an energizer of task-related behaviour is relevant in almost every teaching and learning context, because students become more engaged and learn more when they are interested in the topic. Interest is both a psychological state characterized by increased attention, effort, and affect towards a particular

object or topic (Harackiewicz et al., 2016) and can therefore be seen as a dynamic person-object relation (Harackiewicz & Knogler, 2017).

Interest theories differentiate between two concepts of interest: individual interest and situational interest (Linnenbrink-Garcia et al., 2010). Individual interest is a stable, underlying disposition activated in particular situations and less dependent on situational factors of the learning environment. Situational interest emerges from the situation and is bound to it. It is an immediate consequence of the contextual factors present in a situation. Situational interest consists of two aspects: triggered SI and maintained SI .Triggered SI refers to increased attention elicited by the learning material, and maintained SI refers to corresponding feeling-related aspects of the learning situation. Maintained SI can be further divided into SI-feeling, representing positive affect (e.g., enjoyment), and SI-value, representing the perceived importance of the learning topic (Linnenbrink-Garcia et al., 2010). Repeatedly occurring situational interest can develop into more stable and enduring individual interest that is needed to maintain students' motivation for learning in the domain (Renninger & Hidi, 2016). Maintained-SI provides the link between triggered-SI and individual interest (Linnenbrink-Garcia et al., 2010).

Interest can be triggered and supported to develop at any age; however, triggers for interest are needed (Järvelä & Renninger, 2014). Hidi and Renninger (2006) suggest the potential of their Four Phase Model of Interest development for supporting educational intervention. These four phases (triggered situational interest, maintained situational interest, emerging individual interest, and well-developed individual interest) are considered to be sequential and distinct, and represent a form of cumulative, progressive development in cases where interest is supported and sustained.

Growth mindset interventions aim at promoting students' beliefs toward effort and ability. Students with growth mindsets report valuing learning more (Dweck, 2000) and more

positive attitudes regarding their academic efforts (Aronson et al., 2002). Therefore mindset interventions can foster interest because they facilitate the development of feeling and value-related aspects (positive affects and perceived importance) connected to situational interest. Previous research of Burnette et al. (2019) and Xu et al. (in press) shows that growth mindset interventions may be an effective way to promote maintained SI by increasing positive affect and perceived value. Besides fostering interest, a growth mindset is assumed to reduce feelings of perceived cognitive load (Xu et al., 2020).

1.1.5 Cognitive Load

Cognitive load refers to the load of the information process induced by learning tasks. When students construct knowledge, the human cognitive processing is limited due the working memory capacity which can only process a limited number of information elements at a time (Sweller et al., 2019). Cognitive load theory distinguishes three different types of cognitive load. Intrinsic load relates to the inherent complexity of the task, extraneous load is caused by the external design of the learning task and germane load refers to mental processing, construction and automation of schemas required to learn (Sweller et al., 1998).

After a primarily focus on identifying the mechanisms and strategies to increase learning outcomes, the scope has broaden to interactions between cognitive load and motivation or emotion during learning. Plass and Kalyuga (2019) state that emotions experienced by the learners during processing can be a source of intrinsic cognitive load and extraneous cognitive load and could have an effect on learners' motivation. When a learner feels the task is too difficult or the teacher or material does not explain the task well, a growth mindset could help to reduce the feeling of cognitive load and focus on active learning (Xu et al., 2020). Learners who adopt a growth mindset are more likely to attribute to malleable factors such as effort (Blackwell et al., 2007; Hong et al., 1999) instead of task difficulty or

teacher explaining, and therefore experience a reduced perception of intrinsic and extraneous cognitive load.

According to Sweller et al. (2019) future research should contribute to identifying instructional interventions that help learners deal more effectively with stress, emotions and uncertainty. Since mindset interventions aim at more positive beliefs towards learning, effort, ability and attributions in the face of failure (Blackwell et al., 2007; Hong et al., 1999), a lower perceived cognitive load is expected.

1.2 The Present Study

After decades of research there is still need for more research about how students apply a new mindset and how the concept of mindset fits into larger theories of motivation (Dweck & Yeager, 2019), or more specific, interest as a prototypical motivational construct (Harackiewicz & Knogler, 2017). Based on previous research a growth mindset intervention about the malleability of the brain will be expected to foster situational interest, reduce perceived cognitive load and improve task performance (Blackwell et al., 2007; Burnette et al., 2019; Cook et al., 2017; Xu et al., 2020).

As mentioned, studies with young children and mindset interventions are occasional (Savvides & Bond, 2021). According to Mueller and Dweck (1998) praise for effort can activate a given mindset in the situation for young children in the age of 10 to 12. Renninger (2009) suggest in their inductive model for the development of interest that learners need feedback by which they feel genuinely appreciated for the efforts they have made. Based on these outcomes two growth mindset intervention strategies, i.e., a growth mindset intervention about the malleability of the brain and the use of effort praise, were examined in Dutch primary school children on grades 7 and 8 in a randomized experimental 2 x 2 design.

1.3 Hypotheses

The main research questions and hypotheses of the present study were:

1. What is the effect of a growth mindset reading and writing intervention on mindset belief on Dutch primary school children in grade 7 and 8?

1a. Participants in the growth mindset reading/writing condition will report a higher growth mindset belief than participants in the control condition (manipulation check).

2. What is the effect of a growth mindset intervention on situational interest on Dutch primary school children in grade 7 and 8?

2a. Participants in the growth mindset reading/writing condition will report a higher situational interest than participants in the control condition.

2b. Participants in the praise for effort condition will report a higher situational interest than participants in the control condition.

2c. There is an interaction effect between the two intervention strategies: Participants in the growth mindset reading/writing + praise for effort condition will report a higher situational interest than participants in the control condition.

3. What is the effect of a growth mindset intervention on cognitive load on Dutch primary school children in grade 7 and 8?

3a. Participants in the growth mindset reading/writing condition will report less cognitive load than participants in the control condition.

3b. Participants in the praise for effort condition will report less cognitive load than participants in the control condition.

3c. There is an interaction effect between the two intervention strategies: Participants in the growth mindset reading/writing + praise for effort condition will report less cognitive load than participants in the control condition.

4. What is the effect of a growth mindset intervention on learning performance on Dutch primary school children in grade 7 and 8?

4a. Participants in the growth mindset reading/writing condition will perform better on learning performance than participants in the control condition.

4b. Participants in the praise for effort condition will perform better on learning performance than participants in the control condition.

4c. There is an interaction effect between the two intervention strategies: Participants in the growth mindset reading/writing + praise for effort condition will perform better on learning performance than participants in the control condition.

2. Method

2.1 Design

This study was conducted as a fully randomized experimental 2 x 2 design with four groups. The independent variables were mindset (growth mindset or control) and praise for effort (praise for effort or control). The dependent variables were mindset belief, situational interest, cognitive load, and learning performance. Additionally prior knowledge was measured and included a covariate. Participant were randomly assigned in one of the four experimental groups: the active control condition – no praise + mindset control (1), or in (2) praise for effort + mindset control, (3) No praise + growth mindset reading/writing, or (4) growth mindset reading/writing + praise for effort condition. Mindset belief, situational interest and cognitive load was measured by subject ratings on questionnaire items to answer the hypotheses. Mindset belief was measured twice as a manipulation check. Situational interest and cognitive load were measured once. Prior knowledge and learning performance were measured with scores for each right answer on probability problem calculations.

2.2 Participants

In total, 223 students in the 7th and 8th grade from four primary schools in the south of the Netherlands were approached, 161 gave consent and took part in the experiment. These primary schools were selected based on representative population characteristics like socioeconomic status operationalized by the indicator schoolweging (M = 30) (Inspectie van het Onderwijs, 2020). The minimum age of the participants was 10 years, and the maximum 12 years (M = 10.80, SD = 0.61). Of the participants, there was 55% female (n = 89) and 45% male (n = 72). Participants were randomly assigned to one of the four conditions: control condition (n = 40), praise for effort and mindset control condition (n = 40), growth mindset reading/writing and no praise condition (n = 40), growth mindset reading/writing + praise for effort condition (n = 41). Based on previous experimental research on the effect of mindset interventions (Xu et al., 2020) and a priori power calculation using G*Power (version 3.1.9.7) a sample size of n =171 was originally required for an effect size of Cohen's d = 0.5 (f = 0.25), power = 90%, and type I error rate = 5%.

2.3 Materials and Measurements

All the materials that were used during the experiment were translated to Dutch, checked by a bilingual speaker and adapted for the current sample. The materials are included in the Appendixes at the end of the thesis.

2.3.1 Intervention and Learning Materials

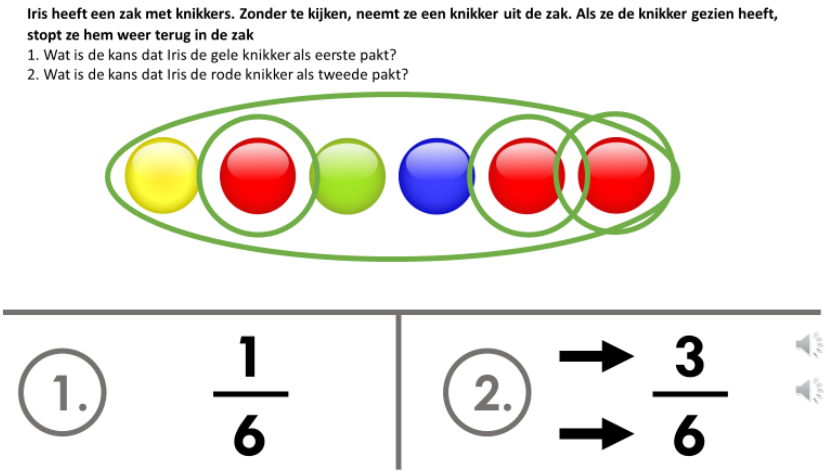
2.3.1.1 Growth Mindset Reading and Writing Assignment. The growth mindset reading and writing assignment (see Appendix A) was successfully used in previous studies (Aronson et al., 2002; Blackwell et al., 2007; Yeager et al., 2016, 2019; Paunesku et al., 2015; Xu et al., 2020). Participants in the growth mindset reading/writing conditions read a scientific article titled "You Can Grow Your Intelligence" adapted from Blackwell et al.

(2007). This article describes the idea that the brain is malleable and can gets stronger like a muscle through practice. After finishing reading, the participants were asked to write a letter of a few sentences with advice to a classmate who is struggling with a subject that's hard for him. These "Saying-is-believing" writing assignment is a self-persuasion strategy (Aronson, 1999) and adapted from Yeager et al. (2016). Participants in the neutral mindset condition read a similar scientific article on general brain functioning titled "The brain is the computer in your head" (see Appendix B) This article doesn't talk about the malleability of the brain. After finishing reading the participants were asked to write a short summary to one of their classmates.

2.3.1.2 Instructional Video and Practise Phase. All participants watched a 4 minute video instruction (see Appendix C) about how to solve probability calculation problems, adapted from Hoogerheide et al. (2014). The video explained step by step how to solve probability problems without replacement. See Figure 1 for a screenshot of the final slide in the video. After the instructional video, the participants were asked to solve four calculating problems similar to the problem explained in the video.

Figure 1

Screenshot instructional video probability problems



2.3.1.3 Praise for Effort. The growth mindset strategy using praise for effort was implemented during the practise phase. After finishing the practise probability problems, the papers were collected by the experimenter to be examined. All participants received feedback with their total score, this score (8) was equal for everyone and representing a success situation, following previous research of Li and Bates (2019) and Mueller and Dweck (1998). Feedback was given individual and handwritten so that it looks authentic. Due to the limited time, prewritten labels were used. Participants in the praise for effort conditions received additional written praise for effort (adapted from Mueller & Dweck, 1998). They were praised for the effort they put in referring to the growth mindset reading and writing task: "You must have put in good effort when you watched the explanation and tried your best to solve these problems. Working hard makes your brain stronger and smarter!". Participants in the control condition did not receive any written remarks apart from the score.

2.3.2 Measurements

2.3.2.1 Prior Knowledge. To control for prior knowledge, four fraction problems and four probability problems were given in the pre-test phase. The probability concept is not part of the primary school curriculum, thus all participants could been seen as novices. Their score on the prior knowledge was expected to be low. One point was given for every right answer.

2.3.2.2 Mindset Belief. Mindset belief was twice measured with the revised Implicit Theories of Intelligence Scale (Self-Theory) (De Castella & Byrne, 2015) based on the original measure by Dweck (1999). This revised version (see Appendix D) is modified to form a first-person, "self-theory" scale and displayed a good internal consistency at baseline ($\alpha = .75$) and at post ($\alpha = .84$). This questionnaire consisted of four items on growth mindset (e.g., "I believe I can always substantially improve on my intelligence") and four items on fixed mindset (e.g., "My intelligence is something about me that I personally can't change

very much"). Items were scored on a six-point Likert-scale from (1) completely disagree to (6) completely agree. The fixed mindset items were reverse coded and combined with growth mindset items to present a single scale for mindset beliefs where a low score (1) denotes a completely fixed mindset and a high score (6) denotes a completely growth mindset.

2.3.2.3 Situational Interest. Situational interest (SI) was measured with the Situational Interest Scale (adapted from Linnenbrink-Garcia et al., 2010) (see Appendix E). This questionnaire consisted of three subscales that each showed a good internal consistency, triggered-SI (α = .91), maintained-SI-feeling (α = .95) and maintained-SI-value (α = .85). There were four items on triggered-SI (e.g., "In the probability video, the instructor explains things that grab my attention"), four items on maintained SI-feeling (e.g., "What we are learning in the probability video is fascinating to me") and three items on maintained SI-value (e.g. "What we are learning in the probability video is useful for me to know"). Items were scored on a ten-point Likert-scale from (1) completely disagree to (10) completely agree.

2.3.2.4 Cognitive Load. Cognitive load was measured with the Cognitive Load Index Scale (adapted from Leppink et al., 2013) (see appendix F). This questionnaire consisted of three subscales that each displayed a good internal consistency, intrinsic load (α = .92), extraneous load (α = .70) and germane load (α = .84). There were three items on intrinsic load (e.g., "The topic covered in the activity was very complex"), three items on extraneous load (e.g., "The instructions and/or explanations during the activity were very unclear") and four items on germane load (e.g., "I could connect the new information I learnt in the probability video to what I already knew about the topic"). Items were scored on a ten-point Likert-scale from (1) completely disagree, to (10) completely agree, and negatively worded items were reverse coded.

2.3.2.5 Learning Performance. Learning performance was based on scores calculated from problems solved by the learners during the performance phase. Participants solved eight

probability problems similar to the problem explained in the video (retention items) and eight probability problems without replacement (transfer items) (see Appendix G). One point was given for every right answer.

2.4 Procedure

The participating primary schools were initially invited by a short introduction of the research via email and social media (LinkedIn) to participate with grade 7 and 8 of their school. After a first contact with the involved teachers, dates were set. Two weeks before the experiment participants and their parents received an information and informed consent letter.

The experiment was conducted in four primary schools during 10 data collection sessions with approximability 16 participants each time. The experiment took place in their own classroom . Participants were randomly assigned to one of the four conditions by corresponding envelopes that were randomly placed on the classroom desks. These envelopes contained all the materials and were marked with an identification number that was used to keep track of the experimental conditions. The experiment was conducted in four phases and lasted 60 minutes total. Every phase was led by the experimenter and participants were asked to work in silence.

In the first phase, all participants filled out general questions about age, gender, group, and prior knowledge. In the second phase participants filled out a questionnaire on mindset, then participants in the experimental condition performed a reading and writing task that was designed to induce a growth mindset. Participants in the control condition performed a neutral reading and writing task. After completing these tasks, students filled out again a questionnaire on mindset. In the third phase all the participants received the same instructional video and probability calculation tasks. First, a short video was shown on the smartboard. After watching the video, participants solved eight probability items and were

asked to place this paper on the left side of the desk. The papers were collected by the experimenter to be examined. In the meanwhile participants could make a little maze puzzle or sudoku, while waiting for feedback. In several minutes, all participants received their paper back with their score (8 out of 10). Participants in the experimental conditional received additional written feedback with praise for effort. In the fourth and final phase, the video was shown again. Then, participants filled out questionnaires on cognitive load and situational interest, and solved the performance test. At the end of phase four all materials were put back in the envelop and selected by the experimenter. After finishing the experiment, participants and their parents received a debrief letter explaining the purpose of the study in more detail than was initially provided.

2.5 Data-Analysis

To test the hypotheses, a quantitative data analysis was carried out with IBM SPSS Statistics (version 27). All data was checked on normality and outliers and assumptions are assessed. The independent variables were the mindset condition (growth mindset or control) and the praise for effort condition (praise for effort or control) and their interaction term. Prior knowledge was included as a covariate. A Mixed ANCOVA was used for the manipulation check. For outcomes on situational interest, cognitive load and learning performance several ANCOVA's were conducted. In this study a level of significance of $p < .05$ was applied and partial η^2 was used as effect size.

3. Results

3.1 Randomization

A sample of 161 participants in the 7th and 8th grade was randomly assigned to the control condition (1), praise for effort and mindset control condition (2), growth mindset reading/writing and no praise condition (3), growth mindset reading/writing + praise for effort condition (4). Randomization was checked for age, mindset belief at baseline and prior knowledge. The mean age of participants was 10.80 years old (SD = .63). Using ANOVA, there was no significant difference in age between the four groups, $F(3, 157) = 0.50$, $p = .684$, partial $\eta^2 = .009$. There was also no significant difference found for prior knowledge $F(3, 157) = 0.27$, $p = .850$, partial $\eta^2 = .005$ and for mindset belief at baseline $F(3, 157) = 0.97$, $p = .410$, partial $\eta^2 = .018$. In sum, the randomization of the four groups was successful. The descriptive statistics were distributed equally across the conditions. Descriptive statistics for all variables can be found in Table 1.

Table 1

Descriptive statistics variables

	Control		Control Praise		Growth Mindset No Praise for Effort		Growth Mindset Praise for Effort	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Prior knowledge	3.13	1.71	3.13	1.91	3.38	1.92	3.39	1.79
Mindset belief baseline	4.07	0.62	4.25	0.80	4.36	0.95	4.29	0.76
Mindset belief post	4.18	0.78	4.43	0.95	4.70	1.20	4.68	0.72
Situational interest total	5.59	2.17	5.70	2.10	5.67	2.53	5.85	2.02
Situational interest triggered	5.33	2.11	5.50	2.33	5.62	2.75	5.69	2.02
Situational interest maintained	5.74	2.29	5.82	2.09	5.68	2.59	5.95	2.16
Situational interest feeling	5.48	2.43	5.67	2.44	5.53	2.90	5.56	2.49
Situational interest value	6.09	2.59	6.03	2.15	5.89	2.74	6.46	2.30
Cognitive load total	2.49	1.34	2.54	1.44	2.80	1.39	2.82	1.47
Cognitive load intrinsic	2.27	1.50	2.19	1.64	2.50	2.01	2.56	2.16
Cognitive load extraneous	2.23	1.70	2.16	1.29	2.18	1.38	2.32	1.45
Cognitive load germane	2.86	1.69	3.08	2.14	3.50	2.36	3.40	1.92
Performance total	11.15	3.17	10.70	4.05	10.30	4.00	11.66	2.87
Performance retention	6.78	2.21	6.75	2.44	6.28	2.57	7.07	1.63
Performance transfer	4.38	1.81	3.95	2.09	4.03	2.09	4.59	1.86
Age	10.85	0.62	10.70	0.72	10.85	0.62	10.80	0.56

3.2 Hypothesis

Growth Mindset (Hypothesis 1)

Hypothesis 1 assumed that Participants in the growth mindset reading/writing condition would report a higher growth mindset belief than participants in the control condition.

While controlling for prior knowledge, an ANCOVA analysis revealed that participants in the growth mindset condition reported a higher growth mindset belief after the growth mindset reading/writing intervention (M = 4.68, SD = 0.98) than participants in the control condition (M = 4.30, SD = 0.87). This difference, the main effect of the intervention, was significant, $F(1, 158) = 6.34$, $p = .013$, partial $\eta^2 = .039$. To take into account of baseline

growth mindset, a mixed ANOVA was used with time as a within subjects factor, and intervention group as a between subjects factor. At baseline, participants in the growth mindset reading/writing intervention reported a mean of $M = 4.33$, $SD = 0.86$ for mindset belief and participants in the control condition reported a mean of $M = 4.16$, $SD = 0.71$. Analysis revealed a significant interaction effect of time and intervention group, $F(1, 158) = 5.44$, $p = .021$, partial $\eta^2 = .033$, and a significant between-subjects effect, $F(1, 158) = 4.22$, $p = .042$, partial $\eta^2 = .026$. This shows that the difference, in terms of growth mindset belief, between baseline and the post-experimental induction, was higher in the growth mindset condition than in the control condition, and that the experimental group scored significant higher on growth mindset belief. This indicates a successful growth mindset manipulation.

Situational Interest (Hypothesis 2)

Hypothesis 2 assumed that participants in the experimental conditions would report a higher situational interest than participants in the control condition. The results for the interaction between the growth mindset reading/writing intervention and the praise for effort condition were expected to be highest.

Participants in the praise for effort condition ($M = 5.82$, $SD = 2.09$) and the growth mindset reading/writing + praise for effort condition ($M = 5.95$, $SD = 2.16$) both showed a higher trend in their scoring on *maintained situational interest* than participants in the control condition ($M = 5.74$, $SD = 2.29$). Participants in the growth mindset reading/writing condition ($M = 5.68$, $SD = 2.59$) scored lower. According to the ANCOVA analysis, controlling for prior knowledge, these mean differences were not significant. There was no main effect for growth mindset reading/writing on maintained situational interest $F(1, 153) = 2.79$, $p = .097$, partial $\eta^2 = .018$, and for praise on maintained situational interest $F(1, 153) = 1.24$, $p = .267$, partial $\eta^2 = .008$. There was also no significant interaction effect for growth mindset

reading/writing and praise on maintained situational interest $F(1, 153) = 0.89$, $p = .348$, partial $\eta^2 = .006$. The covariate, prior knowledge was not significantly related to maintained situational interest $F(1, 153) = 0.18$, $p = .895$, partial $\eta^2 = .000$.

For *situational interest feeling*, participants in all experimental conditions, praise for effort condition ($M = 5.67$, SD = 2.44), growth mindset reading/writing condition ($M = 5.53$, $SD = 2.90$) and the growth mindset reading/writing + praise for effort condition ($M = 5.56$, $SD = 2.49$) showed a higher trend in their scoring on situational interest feeling than participants in the control condition ($M = 5.48$, $SD = 2.43$). According to the ANCOVA analysis, controlling for prior knowledge, these mean differences were not significant. There was no main effect for growth mindset reading/writing on situational interest feeling $F(1, 153) = 2.26$, $p = .135$, partial $\eta^2 = .015$, and for praise on situational interest feeling $F(1, 153) = 0.50$, $p = .480$, partial $\eta^2 = .003$. There was also no significant interaction effect for growth mindset reading/writing and praise on situational interest feeling $F(1, 153) = 0.19$, $p = .663$, partial $\eta^2 = .001$. The covariate, prior knowledge was not significantly related to situational interest feeling $F(1, 153) = 0.00$, $p = .973$, partial $\eta^2 = .000$.

For *situational interest value*, participants in the growth mindset reading/writing + praise for effort condition ($M = 6.46$, $SD = 2.30$) showed a higher trend in their scoring on situational interest value than participants in the control condition ($M = 6.09$, $SD = 2.59$). Participants in the praise for effort condition ($M = 6.03$, $SD = 2.15$) and the growth mindset reading/writing condition ($M = 5.89$, $SD = 2.74$) showed a lower trend in their scoring on situational interest value than participants in the control condition. According to the ANCOVA analysis, controlling for prior knowledge, these mean differences were not significant. There was no main effect for growth mindset reading/writing on situational interest value $F(1, 153) = 2.36$, $p = .127$, partial $\eta^2 = .015$, and for praise on situational interest value $F(1, 153) = 2.07$, $p = .152$, partial $\eta^2 = .013$. There was also no significant

interaction effect for growth mindset reading/writing and praise on situational interest value $F(1, 153) = 2.09$, $p = .150$, partial $\eta^2 = .013$. The covariate, prior knowledge was not significantly related to situational interest value $F(1, 153) = 0.11$, $p = .736$, partial $\eta^2 = .001$.

Cognitive Load (hypothesis 3)

Hypothesis 3 assumed that participants in the experimental conditions would report a lower score on cognitive load than participants in the control condition. The cognitive load scores were expected to be lowest for the interaction between the growth mindset reading/writing intervention and the praise for effort condition.

Participants in the praise for effort condition ($M = 2.54$, $SD = 1.44$), the growth mindset reading/writing condition ($M = 2.80$, $SD = 1.39$) and the growth mindset reading/writing + praise for effort condition ($M = 2.82$, $SD = 1.47$) showed a higher trend in their scoring on cognitive load than participants in the control condition ($M = 2.50$, $SD = 1.34$). According to the ANCOVA analysis, controlling for prior knowledge, these mean differences were not significant. There was no main effect for growth mindset reading/writing on cognitive load $F(1, 153) = 0.72$, $p = .396$, partial $\eta^2 = .005$, and for praise on cognitive load $F(1, 153) = 0.00$, $p = .952$, partial $\eta^2 = .000$. There was also no significant interaction effect for growth mindset reading/writing and praise on cognitive load $F(1, 153) = 1.10$, $p = .295$, partial $\eta^2 = .007$. The covariate, prior knowledge was significantly related to cognitive load $F(1, 153) = 8.67$, $p = .004$, partial $\eta^2 = .054$.

For *intrinsic cognitive load*, the growth mindset reading/writing condition ($M = 2.50$, $SD = 2.01$) and the growth mindset reading/writing + praise for effort condition ($M = 2.56$, $SD = 2.16$) both showed a higher trend in their scoring on intrinsic cognitive load than participants in the control condition ($M = 2.27$, $SD = 1.50$). Participants in the praise for effort condition ($M = 2.19$, $SD = 1.64$) showed a lower trend in their scoring than participants in the

control condition. According to the ANCOVA analysis, controlling for prior knowledge, these mean differences were not significant. There was no main effect for growth mindset reading/writing on intrinsic cognitive load $F(1, 153) = 3.33$, $p = .070$, partial $\eta^2 = .021$, and for praise on intrinsic cognitive load $F(1, 153) = 0.00$, $p = .968$, partial $\eta^2 = .000$. There was also no significant interaction effect for growth mindset reading/writing and praise on intrinsic cognitive load $F(1, 153) = 0.68$, $p = .410$, partial $\eta^2 = .004$. The covariate, prior knowledge was significantly related to intrinsic cognitive load $F(1, 153) = 11.32$, $p < .001$, partial $\eta^2 = .069$.

For *extraneous cognitive load*, participants in the growth mindset reading/writing + praise for effort condition ($M = 2.32$, $SD = 1.45$) showed a higher trend in their scoring on extraneous cognitive load than participants in the control condition ($M = 2.23$, $SD = 1.70$). Participants in the praise for effort condition ($M = 2.16$, $SD = 1.29$) and the growth mindset reading/writing condition ($M = 2.18$, SD = 1.38) both showed a lower trend in their scoring on extraneous cognitive load than participants in the control condition. According to the ANCOVA analysis, controlling for prior knowledge, these mean differences were not significant. There was no main effect for growth mindset reading/writing on extraneous cognitive load $F(1, 153) = 0.30$, $p = .584$, partial $\eta^2 = .002$, and for praise on extraneous cognitive load $F(1, 153) = 0.23$, $p = .632$, partial $\eta^2 = .001$. There was also no significant interaction effect for growth mindset reading/writing and praise on extraneous cognitive load $F(1, 153) = 2.01$, $p = .158$, partial $\eta^2 = .013$. The covariate, prior knowledge was not significantly related to extraneous cognitive load $F(1, 153) = 0.45$, $p = .505$, partial $\eta^2 = .003$.

For *germane cognitive load*, participants in the praise for effort condition ($M = 3.08$, $SD = 2.14$), the growth mindset reading/writing condition (M = 3.50, $SD = 2.36$) and the growth mindset reading/writing + praise for effort condition ($M = 3.40$, $SD = 1.92$) showed a higher trend in their scoring on germane cognitive load than participants in the control

condition (*M* = 2.86, *SD* = 1.69). According to the ANCOVA analysis, controlling for prior knowledge, these mean differences were not significant. There was no main effect for growth mindset reading/writing on germane cognitive load $F(1, 153) = 0.00$, $p = .956$, partial $\eta^2 = .001$, and for praise on germane cognitive load $F(1, 153) = 0.15$, $p = .696$, partial $\eta^2 = .001$. There was also no significant interaction effect for growth mindset reading/writing and praise on germane cognitive load $F(1, 153) = 0.23$, $p = .633$, partial $\eta^2 = .001$. The covariate, prior knowledge was significantly related to germane cognitive load $F(1, 153) = 6.01$, $p = .015$, partial $\eta^2 = .012$.

Learning Performance (hypothesis 4)

Hypothesis 4 assumed that participants in the experimental conditions would perform better on a performance task than participants in the control condition. Performance scores for the interaction between the growth mindset reading/writing intervention and the praise for effort condition were expected to be highest.

Participants in the growth mindset reading/writing + praise for effort condition (*M* = 11.66, *SD* = 2.87), performed better on a performance task than participants in the control condition (*M* = 11.15, *SD* = 3.17). Participants in the praise for effort condition (*M* = 10.70, *SD* = 4.05) and the growth mindset reading/writing condition (*M* = 10.30, *SD* = 4.00) performed less better than the control group. According to the ANCOVA analysis, controlling for prior knowledge, there was no main effect for growth mindset reading/writing on performance $F(1, 153) = 0.39$, $p = .843$, partial $\eta^2 = .000$, and for praise on performance $F(1, 153) = 0.63$, $p = .430$, partial $\eta^2 = .004$. However, there was a significant interaction effect for growth mindset reading/writing and praise on performance $F(1, 153) = 5.96$, $p = .016$, partial $\eta^2 = .037$. The covariate, prior knowledge was significantly related to performance $F(1, 153) = 13.74$, $p = < .001$, partial $\eta^2 = .082$.

Looking at learning performance in terms of *transfer* there is a similar pattern. Participants in the growth mindset reading/writing + praise for effort condition (M = 4.59, SD = 1.86) performed better on a transfer task than participants in the control condition (M = 4.38, SD = 1.81). Participants in the praise for effort condition (M = 3.95, SD = 2.09) and the growth mindset reading/writing condition (M = 4.03, SD = 2.09) performed less better than the control group. According to the ANCOVA analysis, controlling for prior knowledge, there was no main effect for growth mindset reading/writing on performance transfer $F(1, 153) = 0.11$, $p = .740$, partial $\eta^2 = .001$, and for praise on performance transfer $F(1, 153) = 0.52$, $p = .474$, partial $\eta^2 = .003$. However, there was a significant interaction effect for growth mindset reading/writing and praise on performance transfer $F(1, 153) = 5.80$, $p = .017$, partial $\eta^2 = .037$. The covariate, prior knowledge was significantly related to performance transfer $F(1, 153) = 5.55$, $p = .020$, partial $\eta^2 = .035$.

For learning performance in terms of *retention*, participants in the growth mindset reading/writing + praise for effort condition (M = 7.07, SD = 1.63) performed better on a retention task than participants in the control condition (M = 6.78, SD = 2.21). Participants in the praise for effort condition (M = 6.75, SD = 2.44) and the growth mindset reading/writing condition (M = 6.28, SD = 2.57) performed less better than the control group. According to the ANCOVA analysis, controlling for prior knowledge, there was no main effect for growth mindset reading/writing on performance retention $F(1, 153) = 0.00$, $p = .988$, partial $\eta^2 = .000$, and for praise on performance transfer $F(1, 153) = 0.37$, $p = .545$, partial $\eta^2 = .002$. There was no significant interaction effect for growth mindset reading/writing and praise on performance retention $F(1, 153) = 2.89$, $p = .091$, partial $\eta^2 = .019$. The covariate, prior knowledge was significantly related to performance retention $F(1, 153) = 14.05$, $p = < .001$, partial $\eta^2 = .084$.

4. Conclusion and Discussion

The present study aimed to give insights in the effect of fostering a growth mindset on interest, perceived cognitive load, and learning performance. Two intervention strategies were addressed; a growth mindset reading text and writing assignment about the malleability of the brain and a praise for effort strategy. This study confirmed that a growth mindset reading and writing intervention about the malleability of the brain (Blackwell et al., 2007; Yeager et al., 2016) ensured a higher mindset belief. Foremost there was a significant interaction effect for combining a growth mindset reading and writing intervention and a praise for effort intervention (Mueller & Dweck, 1998) on learning performance. However, the assumed effects on interest and perceived cognitive load could not fully be confirmed.

Mindset Belief

In line with previous research (Aronson et al., 2002; Blackwell et al., 2007; Paunesku et al., 2015; Yeager et al., 2016, 2019; Xu et al., 2020) participants in the growth mindset reading/writing condition reported a significant higher mindset belief than participants in the control condition. Where previous studies mainly have been carried out with older children, this study confirms the positive effect of a growth mindset reading and writing intervention on mindset belief for primary school children at the age of 10-12.

Situational Interest and Perceived Cognitive Load

Based on previous research a growth mindset intervention about the malleability of the brain (Blackwell et al., 2007; Burnette et al., 2019; Cook et al., 2017; Xu et al., 2020) and a praise for effort intervention (Mueller and Dweck, 1998) were be expected to foster situational interest and reduce perceived cognitive load. Unfortunately, the results of the present research could not fully confirm this. There were no significant main or interaction effects for both the intervention strategies on situational interest and cognitive load.

The concept of cognitive load perspective might be too much asked for young children as they are still developing metacognitive skills like reflection on what they learned. Questions like *"I could fully understand the concepts covered in the probability video"* are maybe too complex, ant the intern validity should be taken in account.

This also applies for situational interest, and in particular for the value-aspects that representing the perceived importance of the learning topic (e.g. *"What we are studying in the probability video is useful for me to know"*).

Finally, there is a possibility that learning about probabilities wasn't a topic of interest in the first place. Since individual interest is a stable, underlying disposition of situational interest (Harackiewicz & Knogler, 2017) this could have been of influence. In future research a control question concerning interest at baseline could be valuable.

Learning Performance

As predicted there was a significant interaction effect for combining a growth mindset reading and writing intervention and a praise for effort intervention on learning performance. This applied for both performance in general and performance transfer, which means that the students were able to solve the problems similar to the problems explained in the video and additionally were able to successfully meet an academic challenge. These findings suggest that students could benefit from combining these two growth mindset strategies in order to increase learning performance.

4.1 Limitations and Further Directions

As mentioned before, studies with young children are occasional and more exploratory in nature and a mixture of process and outcome evaluations (Savvides & Bond, 2021). The use of questionnaires for outcomes like mindset belief, situational interest and cognitive load gives the opportunity to broad this research in the field and increases extern

validity. On the other hand, the use of questionnaires for children should be discussed. Bell (2007) states that using survey research is feasible from approximately age seven, but recommend for example that negative questions should be avoided and that completely labelled scales (every points has a label) produce a better quality respond than only label the two extremes (1 = completely disagree to 10 = completely agree) . These recommendations could easy be adapted in future research.

Another limitation factor that can play an important role is the amount of reading that had been done during the experiment. Not all children at this age mastering the reading abilities that might be expected (Gubbels et al., 2017), this can have had an effect on perceived cognitive load an interest in general. During the experiment these differences were also observed, some children took long to finish the reading text (growth mindset or control text) and by the time they reached the questionnaires, they were struggling. For future research adjusting the reading text into a short animation video would be an option.

4.2 Implications

The present research contributes to the existing literature on motivation, in particular mindset and interest theories. Within these theories studies with young children and mindset interventions are occasional. Most research currently done focusses on secondary school and higher education students (Savvides & Bond, 2021; Sisk et al., 2018).

Based on the target group, primary school students at the age of 10-12, and previous research (Aronson et al., 2002; Blackwell et al., 2007; Mueller & Dweck., 1998; Paunesku et al., 2015; Yeager et al., 2016, 2019 Xu et al., 2020) a growth mindset reading and writing intervention and a praise for effort intervention was combined. To date, no previous research was done on the effect of both strategies in comparison. The results are promising and encourage further research in order to contribute to the development of effective growth

mindset intervention programmes to optimize the learning process and motivate students. This is especially important for primary school students, since these younger students are still at the beginning of their school career thus motivation intervention programmes might be particularly effective for them.

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Appendixes

Appendix A: Growth mindset reading and writing assignment

You can grow your intelligence

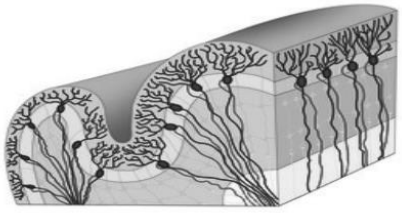
New research shows the brain can develop like a muscle

A lot of people think the brain is full of secrets. 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 throughout your life.

New research shows that brains work more like a muscle that changes and gets stronger when you use it. Scientists have succeeded in showing how your brain grows and gets stronger as you learn.

The brain

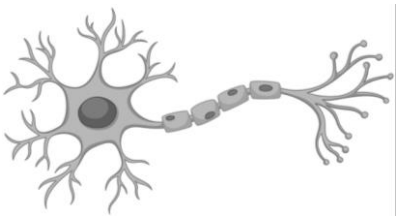
When you practice and learn new things, parts of your brain change and get bigger. This is just like muscles. They also change and get bigger when you exercise.



Part of the cerebral cortex

Inside the outer layer of the brain (the cerebral cortex) there are millions of small nerve cells.

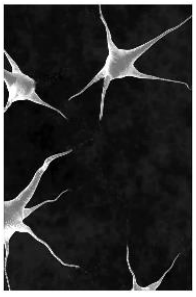
These nerve cells connect to other nerve cells, and make it possible to think and solve problems.



A nerve cell

How do we know the brain can grow stronger?
Scientists began investigating animals. They thought they could see the brains of animals changing and developing.
They found that animals that lived in an environment with lots of toys and other animals were much more active than animals living in an empty cage. Those animals could train their brains by playing with the toys or the other animals.

Effect of a challenging environment



Brains of animals in an empty cage

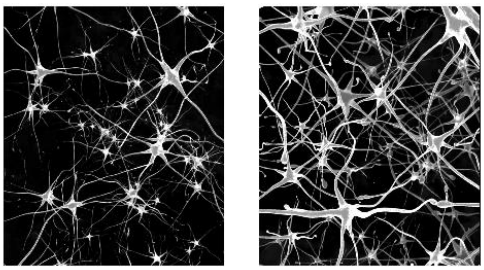
Brains of animals with toys and other animals

These active animals had more and stronger connections between the nerve cells in their brains. Their brains were heavier than the animals that lived in the empty cage. They were also 'smarter', as they were better at solving problems and learning from new things.

Learning mathematics
Scientists also looked at children who learned math. They found that children who exercise more and continue to work in case of problems also learn more.

When children have learned to solve a math problem, it becomes easier next time. This is because the brain has changed. This happens because you've learned something new. The brain has grown and new connections between the nerve cells have been added. The result is that the brain has become stronger and smarter.

Growth of connections between nerve cells



At birth ***6 years old***

When you learn new things, more and more connections will be added. These connections are also getting stronger. The more you challenge your brain to learn, the more your brain cells will grow.

The result is that something that you found difficult or impossible at first is much easier after that. You can think of things like calculating sums or learning a new language. The result is stronger and smarter brains.

The key to growing your brain: practice!
Children from whom everyone thinks that they are 'the smartest' , are maybe born without being very different from others. But perhaps, these 'smart' children may have already started practicing reading before they went to school. They have already worked on their 'reading muscles'. Other children might as well learn to read if they practice as much.

The truth about 'smart' and 'stupid'
No one thinks babies are stupid because they can't solve math problems. They just haven't learned how to do this yet. Still, there are people who call others stupid because they can't solve a math problem or spell a word properly. This while you can learn this by practicing. The more you learn, the easier it becomes to learn new things.

What can you do to get smarter?
Like an athlete, you're going to have to train and practice. When you practice, you make your brain stronger. You will also learn things that will help you to use your brain better.
Only a lot of people miss the chance to make their brains stronger, because they think they can't do it or that it's difficult. It takes effort, but if you feel your brain getting stronger and better, that's worth it!

Assignment
You've probably experienced that you found something difficult at first, but after a lot of practice, effort and hard work you succeeded. For example, you can think of solving calculations. Suppose there is a classmate who finds something very difficult and he/she does not know what to do. What would you say to help him or her? Write that down below

Hi.....I would like to tell you that:

Appendix B: Control reading and writing assignment

The brain is the computer in your head

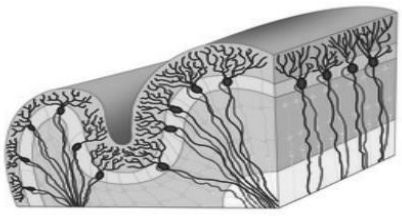
Through research, we already know a lot about the different parts of the brain.

The brains of humans and animals can be compared to a computer. They really take care of everything in your body. For example, your brain ensures that you don't forget to breathe and that you can remember things. In short, anything that makes you live.

Research in recent years has shown how the brain works. Our brains are made up of a lot of brain cells. The amount of cells in our brain is similar to the number of stars in the universe.

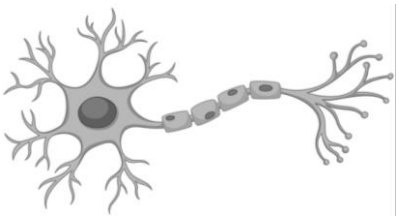
The brain

In addition to all cells, there are many compounds. Simple and difficult tasks are carried out with this. From grabbing a cup of coffee, to making plans for the future.



The outer layer of the brain

The brain consists of three parts. The first part is the brain stem. It makes your heart work, that you can breathe and that your blood keeps flowing. This is all automatic.
For example, you never have to think about making your heart beat again.

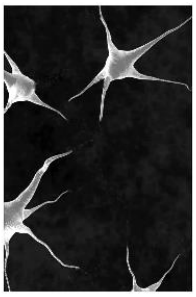


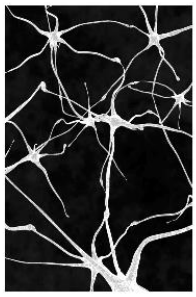
A nerve cell

The second part is the small brain. They make your body move all day long. Your small brain also remembers how to swim, cycle and walk, for example. You hardly have to think about what you're doing with these things.

The third part is the big brain. These consist of two halves: the left and right hemispheres. For example, because of the large brain you can think, hear and watch. But you have to control that yourself and it doesn't happen automatically, like in the small brain.

Brain cells



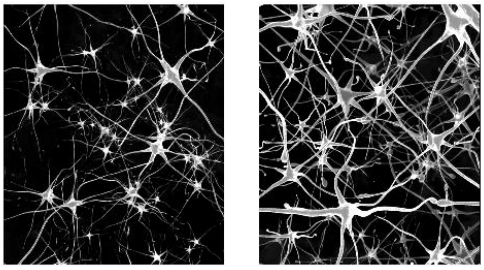


Lobes

The hemispheres of the brain consist of separate pieces. We call those pieces lobes. Each hemisphere has four lobes: the forehead lobe allows you to make decisions, get angry or happy or plan. The wall bone lobe ensures that you can read, calculate, feel, smell and taste.

The occipital lobe allows you to look, move and recognize things.
The temporal lobe ensures that you understand language, can hear, remember things and focus.

The nervous system
Brains are made up of nerve cells. These are very small particles of your body, which you can only see with a microscope. Nerve cells aren't just in your head, they're all over your body. These nerve cells together are the central nervous system.



Connections between brain cells

Nerve cells are actually kind of like little phone calls. They pass all kinds of messages to each other. If you grab a hot pan wrong, nerve cells work very quickly. They will then pass on a message to your hand to let go immediately! We call such a quick reaction a reflex.

As you read this, your heart beats, you breathe and occasionally blink. It's all brain work. That's also done by nerve cells. You got 100 billion of them. They transmit stimuli from your brain to your little toe and back again.

memory
Some nerve cells specialize in smelling or tasting. Others are more for when you feel pain. Some shape your mind. Other nerve cells can be passed on by thinking and giving, for example to move your leg. A lot of your nerve cells go to great lengths to remember things. They form your memory together.
Your memory is divided into a kind of compartment. In one memory box all animals come. In the other box all flavors. In yet another box come all the places you've ever been. Your memory looks like some kind of library. The better you divide this library, the better your memory works.

Brain research
In the old days, they could only look at brains if someone had died. Fortunately, we don't have to anymore and we can scan the brain. Using devices, doctors can look at photos of the brain and do research.

By doing research on the brain, we've already learned a lot of things. However, we still do not know everything and there is therefore plenty that scientists can still do research on. So hopefully we'll find out more about that big computer in our heads soon.

Assignment
You've read a text with information about the brain.
Write a short text to one of your classmates explaining what you've read.
Write that down below

Hi.....
This are the most important things you should know about this text:

Appendix C: Video script

In this video you are going to learn 2 things. You learn what a probability calculation is, and you learn how to calculate a probability.

What is a probability calculation? Probability calculations are a part of mathematics and are about the probability that something can happen or not. We use this to make a prediction about events and things that are going to happen. We would like to know what the chances are that something will happen. For example, predicting the weather.

We would like to know if it is going to rain or not. We can calculate that with a probability calculation. After this calculation, we can say that there is a 10% chance that it will rain. Probabilities are also often written as a fraction.

At the top of the fraction is the number of correct options, at the bottom is the number of options in total. For example, the chance that a dice ends up on three is 1/6. At the top we write down the number of correct options. there is only 1 three on a dice, so there is only 1 right option. At the bottom we write the total number of options. That's 6, because a dice has 6 sides. The chance that a dice ends up on three is therefore 1/6.

Now you're going to learn how to calculate a probability.

Iris has a bag of marbles. Without looking, she takes a marble out of the bag. When she has seen the marble, she puts it back in the bag. She has the following colors of marbles: yellow, red, green, blue, red and red.
What is the chance that Iris will pick up the yellow marble first?
And what is the chance that Iris will take a red marble in second place?

We will first calculate what the chance is that Iris will pick up the yellow marble first.
We first count the right number of options, there is only 1 yellow marble, so 1 right option. We write this at the top of the fraction. Then we count the total number of options, there are a total of 6 marbles, so 6 options in total, we write this at the bottom of the fraction. So the chance that Iris will pick up the yellow marble first is 1/6. Iris then puts the marble back in the bag.

Now we are going to calculate what the chance is that Iris will pick up a red marble second. There are 3 red marbles, so 3 right options. We write this at the top of the fraction. The total number of options is 6, because there are in total 6 marbles. We write this at the bottom of the fraction. The chance that Iris will pick up a red marble second is therefore 3/6.

The answer to the first question, What are the chances that Iris will pick up the yellow marble first? Is 1/6. The answer to the second question, What are the chances that Iris will pick up a red marble as second? Is 3/6

Appendix D: Revised Implicit Theories of Intelligence Scale (Self-Theory)

Questionnaire Please put a round around the right number **1=totally disagree to 6= totally agree**							
1	I don't think I personally can do much to increase my intelligence.	1	2	3	4	5	6
2	Regardless of my current intelligence level, I think I have the capacity to change it quite a bit.	1	2	3	4	5	6
3	I can learn new things, but I don't have the ability to change my basic intelligence.	1	2	3	4	5	6
4	I believe I can always substantially improve on my intelligence.	1	2	3	4	5	6
5	I believe I have the ability to change my basic intelligence level considerably over time.	1	2	3	4	5	6
6	To be honest, I don't think I can really change how intelligent I am.	1	2	3	4	5	6
7	With enough time and effort, I think I could significantly improve my intelligence level.	1	2	3	4	5	6
8	My intelligence is something about me that I personally can't change very much.	1	2	3	4	5	6

Appendix E: Situational Interest Scale

Questionnaire Please put a round around the right number There's no right or wrong. **1=totally disagree to 10= totally agree**		
1	The probability problems of the video are exciting	1 2 3 4 5 6 7 8 9 10
2	In the probability video, the instructor explains things that grab my attention	1 2 3 4 5 6 7 8 9 10
3	The probability video is entertaining.	1 2 3 4 5 6 7 8 9 10
4	The probability problems are so exciting it's easy to pay attention	1 2 3 4 5 6 7 8 9 10
5.	What we are learning in the probability video is fascinating to me	1 2 3 4 5 6 7 8 9 10
6	I am excited about what we are learning in the probability video.	1 2 3 4 5 6 7 8 9 10
6	I like what we are learning in the probability video.	1 2 3 4 5 6 7 8 9 10
8	I find the math in the probability video interesting .	1 2 3 4 5 6 7 8 9 10
9	What we are studying in the probability video is useful for me to know	1 2 3 4 5 6 7 8 9 10
10	The things we are studying in the probability video are important for my future goals	1 2 3 4 5 6 7 8 9 10
11	What we are learning in the probability video can be applied to real life	1 2 3 4 5 6 7 8 9 10

Appendix F: The Cognitive Load Index Scale

Questionnaire Please put a round around the right number **1=totally disagree to 10= totally agree**		
1	The subject of the probability video was very complex	1 2 3 4 5 6 7 8 9 10
2	I found the probability video very complex	1 2 3 4 5 6 7 8 9 10
3	I found the solution method in the probability video complex	1 2 3 4 5 6 7 8 9 10
4	The explanation in the probability video was unclear	1 2 3 4 5 6 7 8 9 10
5	The explanation in the probability video was useful for learning	1 2 3 4 5 6 7 8 9 10
6	The language used in the explanation in the probability video was clear	1 2 3 4 5 6 7 8 9 10
7	I fully understood the solution method of the probability video	1 2 3 4 5 6 7 8 9 10
8	I could fully understand the concepts covered in the probability video	1 2 3 4 5 6 7 8 9 10
9	I now understand how all parts of the probability video were related.	1 2 3 4 5 6 7 8 9 10
10	I could connect the new information I learnt in the probability video to what I already knew about mathematics	1 2 3 4 5 6 7 8 9 10

Appendix G: Examples of the Performance Phase Items

Retention items

Assignment 1

Laura has a jar of marbles. Without looking, she takes a marble out of the jar. When she has seen the marble, she puts it back in the jar. In the jar are the following colored marbles: red, yellow, red, yellow, red.

a. What is the chance that Laura will pick up a red marble first ?	Answer:
b. What is the chance that Laura will pick up a yellow marble second ?	Answer:

Assignment 2

Frank is fishing in a lake. When he catches a fish, he throws it back into the lake. In the lake there are the following fish: pike, carp, pike, pike, pike, carp, carp.

a. What is the chance that Frank will catch a pike first?	Answer:
b. What is the chance that Frank will catch a carp second?	Answer:

Transfer items

Assignment 5

Mandy has a vase with flowers. Without looking, she takes a colored flower out of the vase. When she has the flower, she holds the flower in her hand. In the vase there are flowers with the following colors: purple, purple, green, blue, yellow, red.

a. What is the chance that Mandy will choose purple flower first?	Answer:
b. What is the chance that Mandy will choose a blue flower second?	Answer:

Assignment 6

Daan wants to buy two sweaters. He chooses a sweater without looking. When he has chosen the sweater, he keeps it. In the store he finds sweaters from the following brands:
Nike, Adidas, Adidas, Puma, Nike, Puma.

a. What is the chance that Daan will choose a Nike sweater first?	Answer:

b. What is the chance that Daan will choose an Adidas sweater second?	Answer: