The Effectiveness, Efficiency and Motivational Effect of an Inductive-Expository Information Presentation Strategy for Domain Novices

Master's thesis

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Abstract

Students' average grades and motivation for school are declining over the last eight years. It is therefore important to examine instructional design principles on their effectiveness and efficiency for learning and their motivational effect on students. This study contributes to this by investigating one of the design principles provided by the 4C/ID model (Van Merriënboer & Kirschner, 2018). In this model, it is recommended to present supportive information with an inductive-expository strategy (presenting an example prior to abstract information) to domain novices and to use a deductive-expository strategy (presenting an example after abstract information) for learners with high prior knowledge. The present study investigates whether an inductive-expository strategy is indeed of significant influence on domain novices' learning performance. In addition, this study looks at the effects of this strategy on domain novices' mental effort and addresses the matter of motivation by investigating its effect on domain novices' self-efficacy. A total of 107 domain novices participated in two experimental sessions, in which they were either exposed to the deductive-expository or the inductive-expository information presentation strategy. This study shows that there are no significant differences on learning performance, mental effort and self-efficacy between the two information presentation strategies.

Keywords: Instructional design, deductive-expository, inductive-expository, learning performance, mental effort, self-efficacy

The Effectiveness, Efficiency and Motivational Effect of an Inductive-Expository Information Presentation Strategy for Domain Novices

Over the last eight years, students' average grades and motivation for school are declining in the Netherlands (Inspectie van het Onderwijs, 2020; RTL Nieuws, 2019). There are many possible measures that can be helpful in counteracting this trend. One of the measures that one can take into consideration is the way in which education is designed, since properly designed instruction that is adjusted to the target group can heighten learning gains and motivation among learners (Linnenbrink-Garcia et al., 2016; Paas et al., 2005; Sweller et al., 1998, 2019). Next to the aspects of effectiveness and motivation, educational design is considered beneficial for learning when it is efficient. This entails that learners can obtain the same learning performance while investing less mental effort (Paas & Van Merriënboer, 1993). Whereas research about instructional design has mostly been focused on the aspects of effectiveness and efficiency, studies about the effects on motivation in combination with these cognitive outcomes are more scarce. Considering this in addition to the decline in grades and motivation for school among students, it is important to keep investigating recommended design principles from the literature on these learning outcomes.

One such recommended design principle concerns sequencing strategies for presenting theoretical information to learners. Theoretical information is usually being presented to learners to stimulate the process of elaboration (Van Merriënboer & Kirschner, 2018). Elaboration entails the process in which learners "connect new information elements to each other and to knowledge already available in long-term memory" (Van Merriënboer & Kirschner, 2018, p. 360). For this process to occur, learners can be presented with general, abstract information and examples that illustrate this information. As described by Van Merriënboer and Kirschner (2018), there are two sequencing strategies for presenting the abstract information and examples thereof. The first strategy is described as the deductive-expository strategy, in which learners are first presented with the abstract rule or information, whereafter they are given examples that further represent this information. The deductive approach is assumed to be most effective when learners already have sufficient prior knowledge on the topic, because their prior knowledge causes them to understand abstract information more easily (Van Merriënboer & Kirschner, 2018). The second strategy is described as the inductive-expository strategy. In this approach, learners are first presented with an example of the abstract theory. After that, they are presented with the abstract theory that applies to the example. As stated by Van Merriënboer and Kirschner (2018), this approach may be more effective for learners with little prior knowledge, since it may be easier for them to relate their prior knowledge to concrete examples instead of abstract knowledge.

Although that to our knowledge these presentation strategies have not yet been researched extensively, they are similar to other design principles like the worked-example effect (Sweller, 2006), the concreteness fading strategy (Fyfe et al., 2014), and the eg-rule versus rule-eg sequencing strategies (Hermann, 1971). The worked-example effect and the concreteness fading strategy resemble the idea of the inductive-expository strategy and seem to be effective in enhancing learning performance for domain novices (Chen et al., 2020; Fyfe et al., 2015; Leppink et al., 2014; Van Gog et al., 2011). In terms of efficiency, studies about the worked-example effect show that domain novices perceive less mental effort when they are presented with a worked-out example prior to a problem case than the other way around (Van Gog et al., 2011; Van Harsel et al., 2020). Van Harsel et al. (2020) also reported an increase in domain novices' self-efficacy with this sequencing strategy. Self-efficacy refers to the belief one has in his or her competency to solve problems and has an important positive influence on motivation (Bandura, 1977, 2010). Further, in the concreteness fading literature, it is theorized that presenting information to learners in a concrete to a gradually more abstract way lowers students' mental effort, but empirical research is not yet available (Jaakkola & Veermans, 2020). In addition, research about self-efficacy is lacking in this part of the literature. In contrast to these principles, research about the eg-rule versus rule-eg strategies does not report a significant difference in learning performance between presenting a rule first and the example thereafter versus presenting an example first and the rule thereafter (Hermann, 1978; Jacka & Hermann, 1977). The effects on mental effort and self-efficacy were not investigated in this line of research.

Taken together, there is a need for more research about the deductive-expository versus the inductive-expository information presentation strategy in terms of learning outcomes. Considering the effect other design principles have on domain novices, this study aims to provide more insight into the effects of an inductive-expository information presentation versus deductive-expository information presentation strategy on domain novices' learning performance, mental effort and self-efficacy.

Theoretical framework

According to Van Merriënboer and Kirschner (2018), there are different cognitive processes when it comes to learning and processing information: induction, elaboration, rule formation and strengthening. This study focuses on the cognitive process of elaboration, which is "a category of learning processes by which learners connect new information elements to each other and to knowledge already available in long-term memory" (Van Merriënboer & Kirschner, 2018, p. 360). As described further by the authors, elaboration is the process through which learners learn the information necessary for performing skills like problem-solving and reasoning. This information part is referred to as supportive information and consists of general, abstract information and examples or models thereof (Van Merriënboer & Kirschner, 2018).

When it comes to approaches for presenting this supportive information, there is a distinction between strategies that are inquisitory and expository. In inquisitory-based educational strategies, the emphasis is on discovery and inquiry learning, in which learners are required to construct or discover parts of the general theory themselves (Hammer, 1997; Justice et al., 2007). In contrast, all necessary information is already provided by the teacher in expository strategies (Van Merriënboer & Kirschner, 2018). This study focuses on two information presentation strategies within this expository strategy provided by Van Merriënboer and Kirschner (2018): the deductive-expository strategy and the inductive-expository strategy.

Inductive-Expository and Deductive-Expository Strategies

In the deductive-expository strategy, learners are first presented with abstract information before being presented with examples in which the abstract information is applied. According to Van Merriënboer and Kirschner (2018), this approach is effective for learners who already have sufficient prior knowledge of the domain content, because they can more easily understand the abstract information due to what they already know.

Novice learners, however, do not have the same prior knowledge as more expert learners in their long-term memory. Accordingly, it is hypothesized that the inductive-expository approach is more effective for domain novices (Van Merriënboer & Kirschner, 2018). In this approach, learners are first presented with an example or case in which the abstract theory is applied, whereafter they are presented the abstract information. Van Merriënboer and Kirschner (2018) explain that domain novices are then able to link this abstract information to the example they previously studied. This way, it becomes easier for them to elaborate on their limited prior knowledge with the new, abstract information that is presented.

Similar Educational Design Strategies

The deductive and inductive-expository information presentation strategies closely resemble the eg-rule versus rule-eg sequencing by Hermann (1971). In the eg-rule sequencing, learners are first exposed to an example and after that the corresponding abstract rule, whereas the opposite is true for rule-eg sequencing (Hermann, 1971). In one study by Hermann (1971), it was found that there are no significant differences between the rule-eg versus eg-rule strategy on children's learning performance. While investigating interaction effects between the presentation strategies and age and intelligence, it was suggested that the eg-rule strategy was more suitable for older and more intelligent children (Hermann, 1971). However, in similar studies, no differences between the two strategies were found (Hermann, 1978; Jacka & Hermann, 1977).

Other design principles also resemble the idea of an inductive-expository information presentation strategy, such as the worked-example effect. The worked-example effect states that it is more beneficial for learners to study a step-by-step representation of how to solve a particular problem before trying to solve the problem themselves (Sweller, 2006). These step-by-step examples resemble the idea of providing learners with examples first in the inductive-expository strategy. Research has shown that providing students with a worked-out example first and the problem thereafter is more beneficial for learning performance of domain novices than the other way around (Chen et al., 2020; Leppink et al., 2014; Van Gog et al., 2011). This is because domain novices are then able to construct a cognitive schema for solving the problem case, prior to trying to solve the problem first (Sweller & Cooper, 1985). However, an important difference between the worked-example effect and the inductive-expository strategy is that the worked-example effect entails a part where students have to actively apply their knowledge to solve a problem case, which is not part of the inductive-expository strategy.

Another design strategy linked to the inductive-expository strategy is the concreteness fading strategy. As explained by Fyfe et al. (2014), information is first presented concretely, and is gradually presented in a more abstract manner with this strategy. This process is designed in three stages: the enactive stage, the iconic stage and the symbolic stage. In the enactive stage, a physical or concrete model is shown that functions as the concrete example (Fyfe et al., 2014). In the iconic stage, the same physical or concrete model is presented, but extraneous features not related to the abstract concept are removed and some features of the model are represented as more symbolic or abstract (Fyfe et al., 2014). The physical model is often represented as a picture or graph in this stage (Fyfe et al., 2015). Lastly, the symbolic stage represents the abstract, general model or rule (Fyfe et al., 2014). It is theorized by Fyfe et al. (2014) that this strategy helps domain novices to think abstractly and to understand abstract rules and symbols more easily, leading to better learning performance. Indeed, it is shown that the concreteness fading strategy is effective for enhancing learning performance when compared to presenting only abstract, only concrete or abstract to concrete information among domain novices (Fyfe et al., 2015).

Altogether, there is some ambiguity when it comes to the theoretical recommendations provided by Van Merriënboer and Kirschner (2018) and what can be found in the empirical literature. The worked-example effect and the concreteness fading strategy seem to suggest that there is a positive effect on learning performance when using an inductive-expository information presentation strategy for domain novices, whereas research about the eg-rule versus rule-eg strategy does not seem to suggest any differences between an inductive versus deductive-expository information presentation strategy. Therefore, this study aims to investigate what the effect of an inductive-expository versus a deductive-expository strategy is on the learning performance of domain novices.

Mental Effort

Besides the importance of effectiveness in enhancing learning performance, there is the matter of learning efficiently. As explained by Paas and Van Merriënboer (1993), achieving the same or higher learning performance with less mental effort is considered as more efficient learning. Concrete research into the effects on mental effort has not yet been conducted for the inductive-expository and deductive-expository strategy. In addition, the literature about eg-rule versus rule-eg sequencing also did not yet look into the effects of both strategies on students' mental effort. However, within the literature about the worked-example effect, studies do report less perceived mental effort among domain novices when they are first presented with an example and thereafter the problem than the other way around (Van Gog et al., 2011; Van Harsel et al., 2020). Furthermore, in a study about the concreteness fading strategy, Jaakkola and Veermans (2020) describe that providing learners with examples first prior to abstract information will result in less mental effort. This is explained by the notion that examples make the link between the abstract information and its application in concrete, real-world situations more transparent and therefore reduces the cognitive effort students otherwise have to invest themselves into constructing these connections (Jaakkola & Veermans, 2020). As both the worked-example and concreteness fading strategies resemble the inductive-expository information presentation strategy, this study aims to investigate the effects of this strategy on domain novices' mental effort.

Self-efficacy

Educational design can also be of influence on students' motivation for learning (Linnenbrink-Garcia et al., 2016; Paas et al., 2005). An important factor to consider in motivation is self-efficacy. Self-efficacy refers to the belief or feeling a person has in his or her competency to solve difficult problems (Bandura, 1977). It is positively linked to motivation, in the sense that a person high in self-efficacy will be more likely to put effort into difficult tasks (Bandura, 2010). This effect has also been shown in educational research.

For example, in a study by Pajares (2003), students with higher self-efficacy in their writing skills reported more motivation for writing tasks. In addition, self-efficacy does not only influence motivation for educational tasks, it also enhances learning performance (Chang et al., 2014; Jackson, 2002; Lee & Mao, 2016; Pajares, 2003). Therefore, a higher self-efficacy is beneficial for motivation as well as learning performance.

In the worked-example effect literature, Van Harsel et al. (2020) explain that solving a problem prior to having studied a worked-out example might be too difficult for domain novices, causing them to lose confidence in their own ability to learn the study material. Hence, domain novices' self-efficacy heightens when they are first presented with a worked-out example prior to solving a problem case, as this makes it easier for them to solve the problem and grows their confidence in their own competence (Van Harsel et al., 2020). Indeed, their study shows that providing students with a worked-out example first instead of a problem-case first heightens their self-efficacy (Van Harsel et al., 2020).

However, in the concreteness fading and eg-rule versus rule-eg literature, not much can be found about the effects on self-efficacy. Given the social relevance of the motivational aspect and the effect the worked-example strategy has on students' self-efficacy, this study intends to investigate the effects of an inductive-expository versus a deductive-expository information presentation strategy on domain novices' self-efficacy.

Present Study

Following the aforementioned discussed literature and its findings, the following research question was formulated for the present study: *What are the differential effects of the deductive-expository and inductive-expository information presentation strategies on domain novices' learning performance, perceived mental effort and self-efficacy?* Based on theoretical recommendations and previously discussed research, it is hypothesized that the inductive-expository strategy will result in higher learning performance, lower perceived mental effort and higher self-efficacy for domain novices when compared to a deductive-expository strategy.

Method

Research Design and Participants

The effects of a deductive-expository versus an inductive-expository information presentation strategy were investigated in a randomized two-group design study. This study consisted of two experimental sessions. A minimum amount of $N = 77$ participants was required to find a medium effect size of .15 with a power of .80 (Cohen, 1988). This amount was calculated with the program G*Power (2020), using an alpha of .05 and selecting two groups with three predictors.

Participants were approached via a convenience sample. All participants were enrolled in the '*Instructional Design - Advanced'* course at Utrecht University and their participation in this study's sessions was mandatory. However, the collection and use of their data for this research was voluntary. The participants were informed about the study via an information letter, which is included in Appendix A. Permission regarding the collection and use of the participants' data was asked via active informed consent, described in Appendix A. The data were not fully anonymous, as demographic information about age, gender and study were asked. The data were instead pseudonymized with numbers by the course coordinator. The combination of numbers and names was not accessible to the student-researcher or supervisor. The pseudonymized data are stored at a secured server of Utrecht University for a term of seven years, and only the student-researcher and supervisor have permission for access.

A total of 173 participants participated in the present study. Not all participants were included in the final dataset. Participants who completed one or both sessions too late ($N = 8$), in addition to participants who did not watch the instructional video in one or both sessions (*N* = 51), who only completed one session (*N* = 5) and participants who had an error during the second session and (partly) completed this session a second time (*N* = 2) were excluded. This resulted in a sample of 107 participants, with 54 in the inductive condition and 53 in the deductive condition.

Of the 107 participants, 24 students were enrolled in the bachelor programme Educational Sciences (22.4%), 32 students were enrolled in the pre-master programme (29.9%) and 36 students were enrolled in the '*academic primary teacher education'* programme (33.6%). 15 participants were students from other majors who chose the course electively (14%). The mean age was 22.81 (*SD* = 4.99), with the youngest participants being 18 and the oldest 43. The statistics about age is based on *N* = 106 participants, as there was one missing value about age for one participant. There were 90 women (84.1%), 13 men (12.1%) and 4 participants who preferred not to tell (3.7%) in the sample.

Materials

Study Material

The subject matter for the course the participants were enrolled in consisted mostly of the book Ten Steps to Complex Learning by Van Merriënboer and Kirschner (2018). For the experimental sessions, two subjects from this book were chosen as the educational content the participants were presented with. The first subject was based on the sequencing of learning tasks; the second subject was based on cognitive rules and prerequisite knowledge. Per subject, a video of around 20 minutes was created in which this content was explained to the participants. A short overview of the study materials can be found in Appendix B.

Prior Knowledge Test

The prior knowledge test consisted of seven open questions per session. One example of a question is: "*What are recurrent skills?*". The prior knowledge test is included in Appendix B. The maximum score a student could obtain per session was seven points, with a total of 14 points for both sessions together. A high score on this test represents a high prior knowledge.

Learning Performance Test

The learning performance was measured by twelve multiple-choice questions per session. One example of a test question reads: "*Which sequencing strategy for combining whole-tasks and part-tasks is recommended by the 4C/ID model?"* with answer options (A) *Whole-part sequencing*, (B) *Part-whole sequencing* and (C) *I don't know.* The total score on learning performance a participant could obtain per session was 12 points, with 24 points for both sessions combined. A high score on this test means a high learning performance. The complete learning performance test can be found in Appendix B.

Mental Effort

The mental effort was measured using the Mental Effort scale by Paas (1992). This scale consists of one item with a 9-point rating scale, ranging from (1) *Very, very low mental effort* to (9) *Very, very high mental effort.* The item was formulated in two ways: "*How much effort did it take you to understand the preceding information?*" and "*How much effort did it take you to answer the preceding question(s)?*". A high score on this mental effort scale represents a high amount of mental effort. The scale is included in Appendix B.

Self-efficacy

To measure the self-efficacy of the participants, the Self-Efficacy for Learning and Performance Scale developed by Pintrich et al. (1991) was used. This scale is part of the Motivated Strategies for Learning Questionnaire (Pintrich et al., 1991) and consists of eight items, with answer options ranging from (1) *Not at all true for me* to (7) *Very true for me*. When administering a questionnaire to measure self-efficacy, it is important to use questions that are specifically tailored to the context of the study according to Bandura (1977). Therefore, the formulation of some items was slightly adjusted to fit the context of the study.

For example, the item "*I'm confident I can understand the basic concepts taught in this course*" was formulated into "*I'm confident I can understand the basic concepts taught in this theoretical part of the course*". The adjusted scale is included in Appendix B.

Procedure

This study consisted of two sessions. Beforehand, the participants were randomly divided over the deductive condition and the inductive condition and remained in this condition for both sessions. The first session was about the subject of sequencing learning tasks and was held in the third week of the course. The second session was focused on cognitive rules and prerequisite knowledge and was held in the sixth week of the course. The timing of the sessions was deliberately chosen because it was expected that the participants had low prior knowledge of these subjects in these particular weeks of the course. All sessions lasted about 45 to 60 minutes.

The sessions were held within the online programme Qualtrics (2020). The participants received access to this online environment via an url-link. In the online environment, participants were able to fill out all the required forms and questions and watch the instructional video in the proper sequence. The participants were asked to complete the session individually within the scheduled week of the course.

For both sessions, the procedure was the same. The session started with some demographic questions and the questionnaire about self-efficacy. After this questionnaire, participants were asked to fill in the pre-test about their prior knowledge of the subject. Then, the participants got to the educational part, in which they were presented with the instructional video. The instructional video contained explanations of the abstract concepts from the study material and examples thereof. For the deductive condition, one abstract concept about the subject matter was provided, with an example of that concept thereafter. Then, a second abstract concept was provided, with again an example of that concept thereafter, and so on. This sequence was reversed for the inductive condition: the example was presented first, with the abstract concept thereafter. The examples and abstract concepts were exactly the same for both conditions, with the only difference being the sequence strategy.

After receiving the instructional video, the participants were asked to indicate the amount of mental effort they invested in understanding the content of the instruction video. Thereafter, the participants were asked to fill in the learning performance test. After each test question, an indication of their perceived mental effort was requested. This way, an average representation of their mental effort could be obtained as accurately as possible (Van Gog et al., 2012). Lastly, the participants were again asked to fill in the questionnaire about their self-efficacy. At the end of the session, the students were provided with the answers to the prior knowledge and learning performance tests.

Data Analysis

After all the data were gathered, the research question was answered by conducting analyses in IBM SPSS Statistics (version 26). At first, a Principal Component Analysis was conducted to establish the validity of the self-efficacy scale. Second, a reliability analysis of all used instruments was conducted. After that, descriptive analyses were obtained regarding age, gender and educational background distributions and the Pearson's correlation coefficients were calculated between the dependent variables learning performance, mental effort and self-efficacy. Thereafter, it was checked whether the inductive and deductive group did not significantly differ in their prior knowledge and self-efficacy prior to the sessions. This was analyzed using an independent samples *t*-test. Finally, the research question was answered using a MANOVA, with the information presentation strategy as the independent variable and learning performance, mental effort and self-efficacy as dependent variables.

Before the t-tests and MANOVA were conducted, the assumptions for normality, linearity and homogeneity were checked. The assumption of normality per variabele for each condition was checked using the Shapiro-Wilk test. For some variables, this assumption was violated. For example, the prior knowledge was not normally distributed for the deductive condition ($W(53) = 0.94$, $p = .006$). Further, the learning performance test for the deductive group was not normally distributed ($W(53) = 0.94$, $p = .009$). However, the violation of normality was not expected to be problematic, due to the fact that the sample size was larger than 30 ($N = 107$) (Field, 2018). For all statistical tests, a significance level of .05 was used.

Results

Quality of Instruments

Prior Knowledge

The prior knowledge test was assessed by the student-researcher and a second assessor. The inter-rater reliability was calculated with the intraclass correlation coefficient, using a two-way mixed-effects model and absolute-agreement. For the first test, the inter-rater reliability was excellent, being .91, and the inter-rater reliability for the second test was good, being .89 (Koo & Li, 2016). Because of the high inter-rater reliability, all following analyses are based on the first assessment of the student-researcher.

The reliability of the prior knowledge tests was not sufficient, with $\alpha = .60$ for the test in the first session and $\alpha = .54$ for the test in the second session (Field, 2018). Removal of a few questions per test would result in a slightly higher reliability, but the reliability would not be higher than an acceptable $\alpha = .70$ (Field, 2018). Therefore, no questions were removed from the prior knowledge tests.

Learning performance

The reliability of the learning performance test was not sufficient, with $\alpha = .54$ for the test in the first session and $\alpha = .57$ for the test in the second session (Field, 2018). Removal of a few questions would result in a slightly higher reliability, but no item would result in an acceptable reliability higher than α = .70 when deleted (Field, 2018). Therefore, no questions were removed from the learning performance tests.

Mental effort

The reliability of the mental effort scale was calculated by adding every separate question about mental effort into one reliability analysis. Originally, this scale had a reliability of α = .90 (Paas, 1992). For the present study, the reliability was good, being α = .88 (Field, 2018).

Self-efficacy

For the self-efficacy scale, a Principal Component Analysis was conducted to determine the validity of the adjusted questionnaire. This analysis showed that all eight items measure one underlying factor and that it was not necessary to divide the scale in subscales or remove items from the scale. As the scale measured one factor, the factor loadings could not be obtained in SPSS. Further, as the scale was filled in four times by the participants, a reliability analysis was conducted for each of these four measurement points. Originally, the scale had a reliability of α = .93 (Pintrich et al. 1991). In this study, the reliability was also excellent for each measurement point, with the first being α = .90, the second α = .93, the third α = .92 and the last α = .92 (Field, 2018). For all four reliability analyses, there was no item that would heighten the reliability upon removal from the scale.

Descriptive statistics

Means

Prior to the sessions, the participants reported a below average prior knowledge of the subject matter. The learning performance during the sessions was above average. The participants reported above average mental effort after watching the instruction video and an average amount of mental effort after the learning performance test questions. In terms of self-efficacy, the participants scored above average before the sessions as well as above average after the sessions. For all variables, the range, mean and standard deviation of the total sample and a distinction between the participants in the inductive and deductive condition are included in Table 1. The range is reported as the lowest and highest possible score the participants could obtain.

Table 1

Descriptive Statistics per Variable and per Condition

Variable	Range	M(SD)
Prior knowledge	0-14	3.95 (2.40)
Inductive		4.19 (2.02)
Deductive		3.72 (2.76)
Learning performance	0-24	16.24 (3.40)
Inductive		16.22 (3.24)
Deductive		16.26 (3.59)
Mental effort after video	1-9	5.56 (1.25)
Inductive		5.54 (1.23)
Deductive		5.58 (1.28)
Mental effort after test questions	1-9	4.39 (0.87)
Inductive		4.43 (0.85)
Deductive		4.34 (0.90)
Self-efficacy before session	1-7	4.12 (0.86)
Inductive		3.94 (0.82)
Deductive		4.30 (0.87)
Self-efficacy after session	1-7	4.46 (0.88)
Inductive		4.33 (0.81)
Deductive		4.59 (0.92)

Note. Total $N = 107$, inductive condition $n = 54$, deductive condition $n = 53$.

Correlations

The correlations between the dependent variables are obtained with the Pearson's correlation coefficient (r). Most of the dependent variables are significantly correlated, as shown in Table 2. From the correlations, it can be shown that participants with a higher learning performance reported lower mental effort after the learning performance test questions and a higher self-efficacy. In addition, participants who perceived a higher mental effort after watching the instruction video also perceived higher mental effort after answering the learning performance test questions and reported a lower self-efficacy. Lastly, participants who had a higher self-efficacy, reported lower mental effort after the learning performance test questions.

Table 2

Correlations Between Dependent Variables

	1. LP	2. MEV	3. MET	4. SE
1. Learning performance	-			
2. Mental effort after video	-.11	-		
3. Mental effort after test	-.27**	.37**	-	
4. Self-efficacy after sessions	.41**	-34**	-.50**	-

Note. **p<.01 (two-tailed). *LP* = Learning performance, *MEV* = Mental effort after video, *MET* = Mental effort after test, *SE* = Self efficacy after sessions.

Main analysis

Prior knowledge

The prior knowledge test was conducted in order to check whether the participants were low in their prior knowledge of the subject matter before the sessions and whether the prior knowledge did not differ between the participants in the deductive and inductive condition. Based on the mean scores, it can be argued that the participants had low prior knowledge prior to the sessions (see Table 1). Further, an independent samples *t*-test showed no difference in the prior knowledge between the inductive and deductive condition (t(95,172) = 1.00, p = .320).

Self-efficacy

Before conducting the MANOVA test, it was checked whether the self-efficacy before the sessions did not significantly differ between the participants in the inductive and deductive condition. An independent samples t-test showed that the deductive group had a significantly higher self-efficacy prior to the sessions than the inductive group (t(105) = -2.19, p = .031).

MANOVA

A MANOVA was conducted to test whether the participants in the inductive and deductive condition differed significantly in their learning performance, mental effort and self-efficacy. The assumptions for homogeneity of variances and covariances were met. There was no statistically significant difference on any of these dependent variables between the inductive and deductive condition (F(4, 102) = 0.76, p = .553; Wilk's Λ = 0.97, partial η^2 = .029). This means that the participants in the inductive and deductive group did not significantly differ in their learning performance, mental effort and self-efficacy.

Discussion

This study aimed to investigate whether the inductive-expository information presentation strategy versus a deductive-expository information presentation strategy influences domain novices’ learning performance, mental effort and self-efficacy.

It was expected that an inductive-expository information presentation strategy would result in a higher learning performance than a deductive-expository strategy for domain novices. This first hypothesis was based on research about the worked-example effect and the concreteness fading strategy. The present study did not find any significant differences between the inductive-expository strategy and the deductive-expository strategy in terms of domain novices' learning performance. Therefore, this study is in line with research by Hermann (1978) and Jacka and Hermann (1977) about the eg-rule versus rule-eg strategy that also did not find significant differences between the two presentation strategies on learning performance. However, this is not in line with the findings from research about the worked-example effect and the concreteness fading strategy (Chen et al., 2020; Fyfe et al., 2015; Leppink et al., 2014; Van Gog et al., 2011). There are a few explanations possible for this finding.

First of all, the result could be due to the design of the instructional video for the inductive-expository condition. It is mentioned by Van Merriënboer and Kirschner (2018) that it is important to use multiple examples per abstract rule when presenting information in an inductive manner to learners. This is because multiple examples can point out the similarities between them and this makes it easier for learners to abstract the general rule or information out of the examples (Van Merriënboer & Kirschner, 2018). However, in the present study, there was only one example provided per abstract concept for both the inductive and deductive condition. This was purposefully designed to make the instructional video as equally as possible for both conditions, with the only difference being the sequencing strategy. Perhaps providing one example per abstract concept in the inductive-expository strategy is not sufficient enough for domain novices to cognitively abstract the general concept, and therefore the strategy did not lead to a significant effect on learning performance. Future research could investigate whether adding more examples to the inductive-expository strategy would lead to different results.

Second, it could be that the inductive-expository information presentation strategy is too contrasting from the worked-example effect and the concreteness-fading strategy to generalize their effects on learning performance to the inductive-expository information presentation strategy. In the worked-example effect, students study a worked-out example first and thereafter apply that knowledge to a problem case themselves (Sweller, 2006). This means that learners have to actively and directly apply the information in the example to solve the problem case. With the inductive-expository information presentation strategy, learners only listen to examples and abstract theory in order to elaborate their cognitive schema's (Van Merriënboer & Kirschner, 2018). This is a more passive and implicit process than working out a problem case as students would do in the worked-example effect. Perhaps this passivity and implicitness does not stimulate learners enough to abstract the general information from the examples, leading to a non-significant effect on learning performance.

However, the concreteness-fading strategy is also a strategy in which learners are only presented with information and do not actively or directly apply that information in a problem case (Fyfe et al., 2014). Yet, where the concreteness-fading strategy is effective in terms of learning performance, the inductive-expository strategy is not. This could be explained by the notion that the concreteness-fading strategy involves three steps from a concrete example to the abstract concept, whereas the inductive-expository strategy directly goes from the example to the abstract information. Concretely, the inductive-expository information presentation strategy does not entail the iconic stage that is present in the concreteness fading strategy (Fyfe et al., 2014). In this stage, extraneous features of the model or example that are not relevant to the abstract concept are removed, and some of its features are represented as more symbolic or abstract (Fyfe et al., 2014). It could be that this extra step is of significant importance for domain novices to abstract from the example to the general rule. It is recommended for future research to further look into the specific differences between the inductive-expository strategy and the worked-example effect and the concreteness-fading strategy.

The second hypothesis stated that an inductive-expository information presentation strategy would result in less mental effort for domain novices in comparison to a deductive-expository information presentation strategy. The present study did not find significant differences between the inductive-expository and the deductive-expository information presentation strategy on domain novices' mental effort. Therefore, this result is not in line with the effect the worked-example effect has on lowering domain novices' mental effort (Van Gog et al., 2011; Van Harsel et al., 2020). In addition, it is not in line with the theoretical notion about mental effort in the concreteness fading literature (Jaakkola & Veermans, 2020). One explanation for not finding a significant result on mental effort could lay in the difference between the worked-example effect and the inductive-expository information presentation strategy. As previously explained, the worked-example effect consists of a part in which learners actively apply the information of the example to a problem case that the inductive-expository strategy does not entail. Actively applying information requires more mental effort than passively studying information (Chi & Wylie, 2014). Therefore, a difference in mental effort between an example-problem case and a problem case-example might be more substantial and significant than a difference in mental effort between an inductive-expository versus a deductive-expository strategy. Future research might look further into this alternative explanation.

The third and last hypothesis was that an inductive-expository information presentation strategy would result in higher self-efficacy for domain novices compared to a deductive-expository information presentation strategy. A difference between the inductive-expository versus the deductive-expository information presentation strategy on domain novices' self-efficacy was not found in the present study. One explanation for this finding could lay in the fact that the group of participants who received the deductive-expository strategy were already significantly higher in their self-efficacy prior to the sessions, in comparison to the group who received the inductive-expository strategy. However, based on the self-efficacy means of the inductive-expository and deductive-expository group after the sessions, it does not seem like the inductive-expository group gained significantly more self-efficacy during the sessions than the deductive-expository group. Another explanation for the lack of a significant difference in self-efficacy could again lay in the active, problem-solving part in the worked-example effect that the inductive-expository does not entail. More specifically, van Harsel et. al (2020) explained that when the study material is difficult and not intrinsically motivational, students find it easier to solve a problem when having studied a worked-out example first, instead of having to solve a problem and studying the worked-out example thereafter. Consequently, when a problem case is more easily solved, it can heighten feelings of competence and self-efficacy (Van Harsel et. al, 2020). With the inductive-expository strategy and the deductive-expository strategy, there is no part in which students actively apply their knowledge and receive feedback on their understanding of the material. Therefore, students might not have experienced whether they understood the abstract information better and more easily than they would have when for example solving a problem case. As a result, a significant difference in self-efficacy might not be established between the two strategies.

Finally, an explanation for the non-significant result could lay in the length of the instructional videos and the sessions in general. The study by Van Harsel et al. (2020) about the worked-example effect found that the group who received a worked-out example first and a problem case thereafter reported higher self-efficacy than the group who received this in the opposite order, but that this difference disappeared once the sequences became longer (i.e. repeatedly presenting students with a worked-out example and a problem case). It could be that the same effect occurred in this study, given that the sessions lasted about 45 to 60 minutes with the instructional video being around 20 minutes, in which students were repeatedly presented with examples and abstract information. It is recommended for future research to investigate whether providing students with shorter instructional videos and tests might result in different outcomes when it comes to self-efficacy.

Limitations

When interpreting the results of the present study, one should keep in mind some of the limitations of this research. One important limitation is that the experimental sessions were not held in a controlled environment, but were filled in online by participants in their own time and at their place of preference. Therefore, it was not fully controlled whether the participants completed both sessions as optimally as possible. For example, some students might not have been able to find a place where they could optimally concentrate and it cannot be said with certainty that students did not look up some of the answers on the learning performance tests. Factors like these could have been of influence on this study's findings. It is recommended for future research with similar experiments to choose more controlled environments to prevent influence of similar factors on the results.

Second, the learning performance tests and the prior knowledge tests in this study were of low reliability. This could be due to the fact that both tests were constructed by the student-researcher herself and not tested on reliability prior to the sessions. This makes that the results about prior knowledge and learning performance should be interpreted with caution.

Lastly, the sample used in this study was based on a convenience selection method, resulting in a group of highly educated young adults with an interest in the subject matter. Therefore, the effects of this study are not generalizable to other groups of students, such as primary or secondary education students or students with lower educational backgrounds. It would be interesting to study the effects of the inductive-expository versus deductive-expository information presentation strategy on learning outcomes of other types of students. In addition, this study only investigated domain novices and was not able to directly compare domain novices to domain experts. Further research could investigate whether comparing domain novices and experts simultaneously would perhaps result in different or more elaborated results.

Conclusion

The present study shows that both the inductive-expository and deductive-expository information presentation strategies have an equal effort on domain novices' learning performance, mental effort and self-efficacy. Based on these results, one could argue that it does not matter which strategy one chooses when it comes to presenting abstract information and examples thereof to domain novices in order to heighten their grades and motivation for school. In general, it is recommended for future research to look further into comparisons between domain novices and experts and to study the effects of the inductive-expository and deductive-expository strategy for students with different characteristics than the present study.

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Appendix A - Informal letter and informed consent

Informatiebrief

Research on the Effect of Presentation Strategies and Retrieval Practice
February 2021, Utrecht

Beste student,

Door middel van deze brief willen wij jouw toestemming vragen om deel te nemen aan onze master onderzoeken van de Universiteit Utrecht. Deze onderzoeken worden uitgevoerd in het kader van de master Educational Sciences en staan onder leiding van prof. dr. L. Kester.

Doel van het onderzoek

Het onderzoek zal bestaan uit drietal verschillende studies. De eerste studie zal uitgevoerd worden door Chantal de Lau. Deze studie heeft als doel om het effect van verschillende presentatie manieren van ondersteunende informatie te onderzoeken. De tweede studie zal uitgevoerd worden door Naomi van der Horst. Deze studie heeft hetzelfde doel als het onderzoek van Chantal de Lau, met als extra onderzoekscomponent motivatie. De derde studie zal uitgevoerd worden door Eline Suijten. Deze studie heeft als doel om het effect van twee verschillende manieren van stampen op leren te onderzoeken.

Alle drie de studies zullen bestaan uit een tweetal lessen in sessie van max 90 minuten, welke gevolgd moeten worden in week twee tot en met zeven van het vak *Ontwerpen van Leersituaties- gevorderd* (OVL-g). De in totaal zes lessen vinden plaats in Qualtrics. In week 2 t/m 7 van de cursus OVL-G vinden jullie een link in Blackboard naar elke les in Qualtrics. In deze lessen zal je onder andere filmpjes bekijken met uitleg over de leerstof, een quiz hierover maken en algemene vragenlijsten invullen. Ons verzoek aan jou is om gebruik te mogen maken van jouw data uit deze lessen voor onderzoeksdoeleinden.

Compensatie

Deelname aan de zes online lessen is een van de vereiste van het vak *Ontwerpen van Leersituaties-gevorderd*. Er staat geen financiële vergoeding tegenover deelname aan dit onderzoek.

Datamanagement

Bij dit onderzoek worden in Qualtrics data van jou verzameld. Deze data zijn nodig om de onderzoeksvragen te beantwoorden. De data zullen gepseudonimiseerd worden, waardoor de verkregen data niet meer naar jou herleidbaar zijn. De data zullen opgeslagen worden in YODA waar alleen de onderzoekers en de begeleider toegang tot hebben.
Je data zullen bewaard worden voor een termijn van 7 jaar. Dit is volgens de wetgevingen van de VSNU, voor meer informatie over privacy kunt de volgende site raadplegen: https://autoriteitpersoonsgegevens.nl/nl/onderwerpen/avg-europese-privacywetgeving

Participatie

Deelname aan de lessen is een vereisten voor het vak *Ontwerpen van Leersituaties*. Dat houdt in dat je verplicht bent om de lessen te doorlopen en de quizzen te maken. Echter ben je niet verplicht mee te doen aan het onderzoek: je kan zelf toestemming geven of wij je data mogen opslaan en gebruiken of dat je dat liever niet wilt. Je hebt ook altijd de mogelijkheid om na het afronden van de studies een verzoek te doen tot verwijdering van jouw data. Hiervoor kan je contact opnemen met de student-onderzoeker of de begeleider.

Contactpersoon

Als je vragen of opmerkingen hebt over het onderzoek, dan kunt u contact opnemen met Lisette Hornstra, (t.e.hornstra@uu.nl)

Als je officiële klachten heeft over het onderzoek, kunt u een mail sturen naar de klachten officier:
klachtenfunctionaris-fetcsocwet@uu.nl

Als je, na het lezen van deze informatiebrief, besluit goedkeuring te geven voor het gebruiken van jouw data, kan je hiervoor op de volgende pagina toestemming geven.

Met vriendelijke groet,

Chantal de Lau,
c.m.a.delau@students.uu.nl
Naomi van der Horst,
n.vanderhorst2@students.uu.nl
en Eline Suijten
e.suijten@students.uu.nl

Informed consent

Statement of consent

Hierbij verklaar ik dat ik de informatiebrief betreffende de onderzoeken “Students’ Information Retention: A Comparison Between Two Forms Of Retrieval Practice”, “The Effect of Prior Knowledge on Learning Performance when Providing Supportive Information” en “The effectiveness, efficiency and motivational effect of an inductive-expository information presentation strategy for domain novices” nauwkeurig gelezen heb en ik toestemming geef voor het opslaan en gebruiken van mijn data voor het onderzoek.

Hiermee geef ik toestemming tot:

1. Deelname aan het onderzoek
2. Het verzamelen van mijn data

- ○ Ik ga akkoord

Appendix B - Overview of used materials and questionnaire

Studiematerialen
Sessie 1

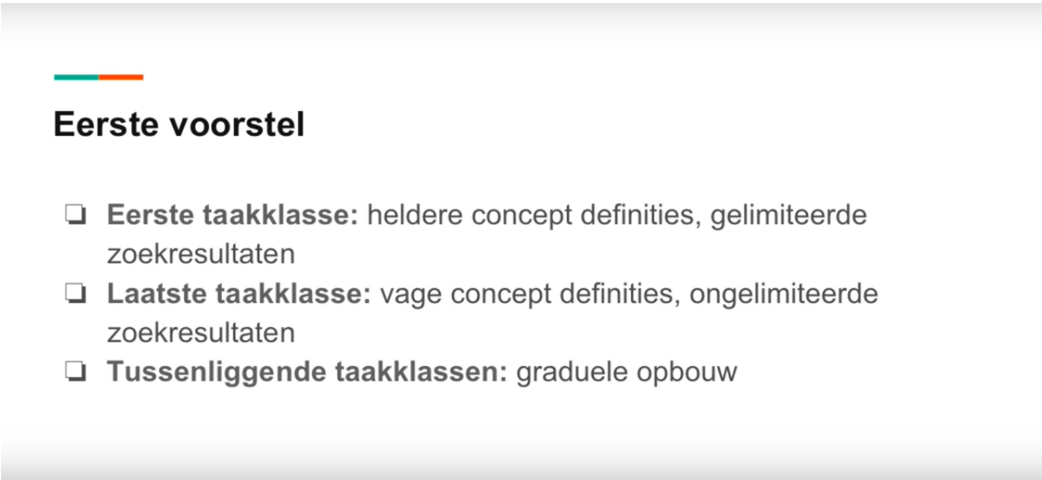
Hoofdstuk Ten Steps to Complex Learning: 6

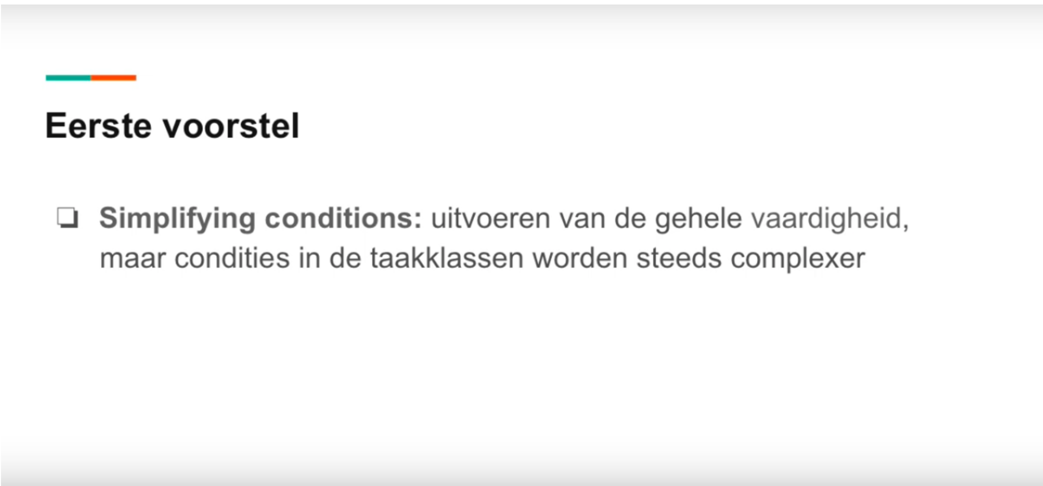
Begrippen: Whole-tasks, part-tasks, simplifying conditions, emphasis manipulation, knowledge progression, scaffolding, forward en backward chaining, snowballing, whole-part sequencing en part-whole sequencing.

Casus: ‘zoeken naar literatuur’, bron:

Van Merriënboer, J. J., Clark, R. E., & De Croock, M. B. (2002). Blueprints for complex learning: The 4C/ID-model. *Educational technology research and development*, *50*(2), 39-61

Screenshots van de instructievideo ter illustratie:





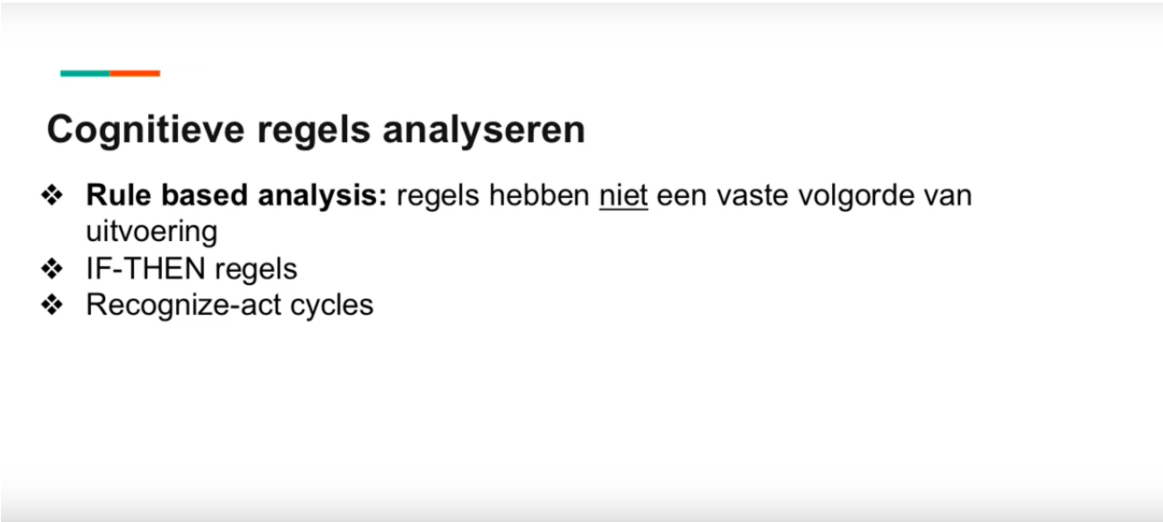
Sessie 2

Hoofdstukken Ten Steps to Complex Learning: 11 en 12

Begrippen: Cognitieve regels, recurrente vaardigheden, IF-THEN regels, rule-based analysis, conflict resolution, information-processing analysis, flowchart, typical errors, malrules, prerequisite kennis, conceptuele kennis, concepten, plannen, principes, facts, fysieke modellen, misconcepties.

Casus: fotografie (zelf opgesteld)

Screenshots van de instructievideo ter illustratie:



Vragenlijst

Introductietekst
Beste student,

Welkom bij deze tweede sessie van de cursus OVL - gevorderd. In de eerste sessie van deze cursus heb je al informatie gekregen over de bedoeling van deze sessies. Ook heb je daarbij aangegeven of ik jou data mag worden gebruikt voor mijn thesis onderzoek. Gezien je in de eerste sessie al je informed consent hierover hebt gegeven, zal dat bij deze en volgende sessies niet meer gevraagd worden.

De sessie van deze week gaat over het sequencen (op volgorde zetten) van leertaken. Je zult eerst wat algemene vragen krijgen, vervolgens een korte vragenlijst over jouw motivatie en daarna zal je een kleine vragenlijst krijgen waarin jouw voorkennis over het onderwerp wordt gemeten. Dan krijg je een instructievideo te zien waarin (een groot deel van) de theorie van deze week wordt uitgelegd. Daarna krijg je een korte vragenlijst over jouw kennis van de stof en daarbij wordt er gevraagd naar jouw geïnvesteerde mental effort. Aan het einde zal je opnieuw de vragenlijst over motivatie tegenkomen. De gehele sessie zal ongeveer een drie kwartier tot een uur in beslag nemen.

Per onderdeel zal er eerst een korte instructie worden gegeven. Lees deze instructie goed door. Voor alle antwoorden geldt dat je zo eerlijk mogelijk mag zijn: als je een antwoord niet weet, is dat niet erg. Vul dan 'weet ik niet' in of klik deze optie aan. Er zijn geen enkele consequenties verbonden aan jouw antwoorden: de antwoorden worden enkel en alleen gebruikt voor mijn masterthesis onderzoek. Verder is het voor het onderzoek belangrijk dat je begrijpt dat het uitdrukkelijk niet de bedoeling is dat je extra studiemateriaal gebruikt en/of antwoorden opzoekt. Ook is het de bedoeling dat je de gehele sessie in één keer afrondt. Daarmee zijn jouw antwoorden voor mijn onderzoek zo betrouwbaar mogelijk.

Mocht je vragen hebben of gaat er iets niet helemaal goed met de survey, neem dan contact met mij op: n.vanderhorst2@students.uu.nl.

Alvast veel plezier en succes met deze sessie!

Algemene vragen

1. Wat is je participantennummer?

2. Wat is je geslacht?
    - Man
    - Vrouw
    - Anders/Zeg ik liever niet

3. Wat is je leeftijd?

4. Welke studie volg je?
   a. Bachelor onderwijswetenschappen
   b. Bachelor ALPO
   c. Pre-master onderwijswetenschappen
   d. Pre-master ALPO
   e. Anders: …

Eerste sessie - leertaken

Soort toets	**Soort vraag**	**Format**	**Aantal**	**Totaal**
Voorkennis	Algemene kennis	Open	7	**7**
Leerprestatie	Algemene kennis	Meerkeuze	6	**12**
	Herkenning/met context	Meerkeuze	6	

Voorkennistoets
De volgende vragen worden gesteld om te meten hoeveel kennis je al hebt van het onderwerp. Geef kort en bondig antwoord. Als je een vraag niet weet, is dat niet erg. Kies dan voor het antwoord 'weet ik niet'. Er zijn geen consequenties verbonden aan jouw antwoorden. Let op: het is <u>niet</u> de bedoeling studiemateriaal te gebruiken en de antwoorden op te zoeken!

1. Wat is het verschil tussen *whole-tasks* en *part-tasks?*
2. Geef kort een uitleg van het begrip *scaffolding* en hoe je dit toepast in het sequencen van leertaken.
3. Wat zijn de twee manieren waarop je *part-tasks* op volgorde kunt zetten?
4. Wat houdt *snowballing* in?
5. Wordt snowballing in aangeraden door 4C/ID, en waarom wel of niet?
6. Wat is het verschil tussen een *part-whole* volgorde en een *whole-part* volgorde?
7. Welke van deze twee strategieën heeft de voorkeur volgens het 4C/ID model?
   Antwoordoptie: open vragen.

   Antwoordmodel:

1. *Whole-tasks zijn gehele taken waarin alle onderdelen van de vaardigheid in 1 taak zijn opgenomen. Part-tasks zijn taken waarin alleen 1 of een paar onderdelen van de gehele vaardigheid is opgenomen.*

2. *Scaffolding houdt in dat de begeleiding en ondersteuning afneemt naarmate de leerling meer expertise ontwikkeld. In het 4C/ID is dit vormgegeven door in de taakklassen eerst veel en gradueel minder ondersteuning te bieden over de leertaken.*
3. *Backward chaining en forward chaining.*
4. *Bij snowballing neem je de vorige taakcluster mee in het nieuwe taakcluster. De leertaken in de taakclusters worden zo steeds uitgebreider: elke keer komen er nieuwe onderdelen van de gehele taak bij.*
5. *Ja, hiermee voeren de leerlingen uiteindelijk alle taakclusters (en dus de hele taak) uit en het bevorderd integratie van de gehele vaardigheid en coördinatie van kennis, skills en attitudes.*
6. *Bij een part-whole volgorde ontwerp je eerst taakclusters en verdeel je alle taakclusters in taakklassen, bij een whole-part volgorde ontwerp je eerst taakklassen en deel je de taakklassen op in taakclusters.*
7. *Whole-part methode.*

Vragen en opdrachten
De volgende vragen worden gesteld om jouw kennis over het onderwerp te meten, nadat je de instructievideo hebt bekeken. Probeer de vragen zo goed mogelijk te beantwoorden. Als je een vraag niet weet, is dat niet erg. Kies dan voor het antwoord 'weet ik niet'. Er zijn geen consequenties verbonden aan jouw antwoorden. Let op: het is niet de bedoeling studiemateriaal te gebruiken en de antwoorden op te zoeken!

Verder wordt er na elke vraag gevraagd hoeveel mentale effort het je kostte om de vraag te beantwoorden.

Algemene kennisvragen

K1. "Ondersteuning in het maken van leertaken, die afneemt naarmate de leerling steeds meer zelf kan". Deze omschrijving hoort bij het begrip:

A. **Scaffolding**
B. Ondersteunende informatie
C. Weet ik niet

K2. "Het op volgorde zetten van leertaken, op basis van steeds verder uitgebreide mentale modellen" is een voorbeeld van:

A. Snowballing
B. **Knowledge progression**
C. Weet ik niet

K3 MC. Welke van de volgende twee heeft de voorkeur volgens het 4C/ID model?

A. **Whole-tasks**
B. Part-tasks
C. Weet ik niet

K4. Bij de keuze tussen de methode van simplifying conditions, emphasis manipulation en knowledge progression, heeft simplifying conditions de voorkeur volgens het 4C/ID model.

A. Waar
B. Niet waar
C. Weet ik niet

K5 MC. Welke van de volgende strategieën wordt door het 4C/ID model gezien als de meest effectieve strategie voor het op volgorde zetten van part-tasks?

A. Forward chaining met snowballing
B. Backward chaining met snowballing
C. Weet ik niet

K 6 MC. Welke manier wordt aanbevolen door het 4C/ID model voor het combineren van whole-tasks en part-tasks?

A. Whole-part sequencing
B. Part-whole sequencing
C. Weet ik niet

Herkenningsvragen

Lees eerst het volgende voorbeeld door.

Een wiskundedocent wil lessen en opdrachten over de stelling van pythagoras ontwerpen volgens het 4C/ID model. De stelling van pythagoras is een wiskundige stelling voor het bereken van de lengte van een zijde van een rechthoekige driehoek. Voor het leren van deze wiskundige stelling hebben de leerlingen de volgende vaardigheden nodig:

1. Leerlingen moeten kunnen herkennen bij welke driehoeken de stelling van pythagoras kan worden gebruikt.
2. Leerlingen moeten een correcte schets kunnen maken van de driehoek in hun schrift.
3. Leerlingen moeten een correcte tabel kunnen opstellen voor de berekening.
4. Leerlingen moeten een correcte berekening kunnen uitvoeren op basis van de gemaakte tabel.

De volgende vragen zijn gebaseerd op dit voorbeeld.

H1. De docent besluit taken te maken waarin de leerlingen alle vier de stappen van de stelling van pythagoras doorlopen. Met welk begrip wordt zo'n taak uitgedrukt?

A. Whole-task
B. Part-task
C. Weet ik niet

H2 MC. De docent maakt de volgende opzet: de leerlingen krijgen verschillende opdrachten in taakklassen waarin zij de gehele berekening van de stelling van pythagoras moeten uitvoeren en per taakklasse licht de docent er 1 van de 4 verschillende vaardigheden uit. Welk begrip herken je in deze situatie?

A. Simplifying conditions
B. Emphasis manipulation
C. Weet ik niet

H3 MC. De docent maakt 4 opdrachten, waarbij ze voor elke vaardigheid 1 opdracht heeft gemaakt. De leerlingen maken eerst opdrachten waarbij ze een correcte berekening moeten uitvoeren. Daarna krijgen de leerlingen opdrachten waarbij ze een correcte tabel moeten invullen. Vervolgens maken de leerlingen een opdracht waarbij ze driehoeken leren schetsen en als laatste een opdracht waarbij ze de juiste driehoeken moeten herkennen. Welke strategie heeft de docent hier gebruikt?

A. Forward-chaining
B. Backward-chaining
C. Weet ik niet

H4 De docent past de volgorde van de vorige opdracht aan. Deze ziet er nu als volgt uit: De leerlingen moeten eerst een correcte berekening maken op basis van een tabel. Vervolgens moeten zij een correcte tabel opstellen en een berekening maken. Daarna krijgen ze de taak een schets van een driehoek te maken, een correcte tabel op te stellen en een berekening uit te voeren. Als laatste taak voeren de leerlingen alle vier de stappen zelfstandig uit. Wat is de correcte benaming voor deze strategie?

A. Part-whole sequencing
B. Snowballing
C. Weet ik niet

H5 De docent combineert whole-tasks en part-tasks in het volgende voorbeeld. Ze ontwerpt verschillende opdrachten waarbij de leerlingen alle 4 de stappen in elke opdracht tegenkomen of moeten uitvoeren. Eerst ontwerpt ze een taakklasse waarin ze de meest simpele opdrachten stopt. Binnen deze taakklasse voeren de leerlingen eerst opdrachten uit waarbij ze zelf de berekening moeten maken, maar waarbij de rest van de stappen al gegeven zijn. Daarna maken de leerlingen opdrachten waarbij ze de tabellen en berekening zelf moeten maken, maar waarbij de rest van de stappen al gegeven zijn. Dit gaat zo verder tot de leerlingen alle stappen zelf uitvoeren. Als de leerlingen klaar zijn met deze taakklasse, gaan zij verder naar de volgende taakklasse waar het proces van vooraf aan begint. Echter, hierbij zijn alle opdrachten een stapje moeilijker gemaakt. En wanneer de leerlingen klaar zijn met deze taakklasse, begint het proces zich weer van voor af aan, maar dit keer krijgen zij de moeilijkste opdrachten voorgelegd.

Van welke sequencing techniek is in dit voorbeeld sprake?

A. Part-whole sequencing
B. Whole-part sequencing
C. Weet ik niet

H6 In het voorbeeld van vraag 5 is de docent een onderdeel vergeten toe te voegen aan haar ontwerp. Zij moet nog toevoegen:

A. **Support**
B. Skill clusters
C. Weet ik niet

Tweede sessie - cognitieve regels en *prerequisite* kennis

Introductietekst
Beste student,

Welkom bij de vijfde sessie van de cursus OVL - gevorderd. In de eerste sessie van deze cursus heb je al informatie gekregen over de bedoeling van deze sessies. Ook heb je daarbij aangegeven of ik jou data mag worden gebruikt voor mijn thesis onderzoek. Gezien je in de eerste sessie al je informed consent hierover hebt gegeven, zal dat bij deze en volgende sessies niet meer gevraagd worden.

De sessie van deze week gaat over cognitieve regels en prerequisite kennis. Je zult eerst wat algemene vragen krijgen, vervolgens een korte vragenlijst over jouw motivatie en daarna zal je een kleine vragenlijst krijgen waarin jouw voorkennis over het onderwerp wordt gemeten. Dan krijg je een instructievideo te zien waarin een deel van de theorie van deze week wordt uitgelegd. Daarna krijg je een korte vragenlijst over jouw kennis van de stof en daarbij wordt er gevraagd naar jouw geïnvesteerde mental effort. Aan het einde zal je opnieuw de vragenlijst over motivatie tegenkomen. De gehele sessie zal ongeveer een drie kwartier tot een uur in beslag nemen.

Per onderdeel zal er eerst een korte instructie worden gegeven. Lees deze instructie goed door. Voor alle antwoorden geldt dat je zo eerlijk mogelijk mag zijn: als je een antwoord niet weet, is dat niet erg. Vul dan 'weet ik niet' in of klik deze optie aan. Er zijn geen enkele consequenties verbonden aan jouw antwoorden: de antwoorden worden enkel en alleen gebruikt voor mijn masterthesis onderzoek. Verder is het voor het onderzoek belangrijk dat je begrijpt dat het uitdrukkelijk niet de bedoeling is dat je extra studiemateriaal gebruikt en/of antwoorden opzoekt. Ook is het de bedoeling dat je de gehele sessie in één keer afrondt. Daarmee zijn jouw antwoorden voor mijn onderzoek zo betrouwbaar mogelijk.

Let op:
Voor deze sessie is het belangrijk dat je je participantennummer goed invult, zodat je in de juiste conditie terecht komt. Vanwege wat technische instellingen zul je je participantennummer pas invullen nadat je de vragenlijsten over je motivatie en de voorkennisvragen hebt gehad.

Mocht je vragen hebben of gaat er iets niet helemaal goed met de survey, neem dan contact met mij op: n.vanderhorst2@students.uu.nl.

Alvast veel plezier en succes met deze sessie!

Soort toets	**Soort vraag**	**Format**	**Aantal**	**Totaal**
Voorkennis	Algemene kennis	Open	7	**7**
Leerprestatie	Algemene kennis	Meerkeuze	6	**12**
	Herkenning/met context	Meerkeuze	6	

Voorkennistoets
De volgende vragen worden gesteld om te meten hoeveel kennis je al hebt van het onderwerp. Geef kort en bondig antwoord. Als je een vraag niet weet, is dat niet erg. Kies dan voor het antwoord 'weet ik niet'. Er zijn geen consequenties verbonden aan jouw antwoorden. Let op: het is <u>niet</u> de bedoeling studiemateriaal te gebruiken en de antwoorden op te zoeken!

1. Voor welk hoofdcomponent uit het 4C/ID model gebruik je cognitive regels en *prerequisite* kennis?
2. Wat zijn *recurrente* vaardigheden?
3. Welke twee technieken worden in het boek beschreven voor het analyseren van cognitieve regels?
4. Wat wordt er bedoeld met *prerequisite* kennis?
5. Wat is een IF-THEN regel?
6. Noem de twee begrippen waarmee fouten in cognitieve regels mee worden aangeduid.
7. Uit welke drie componenten bestaat het tweede level van conceptuele kennis?
   Antwoordoptie: open vragen.

Antwoordmodel:
1. Procedurele informatie
2. Vaardigheden in een complexe taak die nagenoeg hetzelfde zijn per probleemsituatie.
3. Rule-based analysis en information processing analysis
4. De voorkennis die leerlingen nodig hebben om de cognitieve regels te begrijpen
5. Een voorbeeld van een cognitieve regel. De IF-THEN regel beschrijft onder welke condities je welke actie moet ondernemen
6. Typical errors en malrules
7. Concepten, plannen en principes

Vragen en opdrachten
De volgende vragen worden gesteld om jouw kennis over het onderwerp te toetsen. Probeer de vragen zo goed mogelijk te beantwoorden. Als je een vraag niet weet, is dat niet erg. Kies dan voor het antwoord 'weet ik niet'.

Algemene kennisvragen

De volgende vragen worden gesteld om jouw kennis over het onderwerp te meten, nadat je de instructievideo hebt bekeken. Probeer de vragen zo goed mogelijk te beantwoorden. Als je een vraag niet weet, is dat niet erg. Kies dan voor het antwoord 'weet ik niet'. Er zijn geen consequenties verbonden aan jouw antwoorden. Let op: het is niet de bedoeling studiemateriaal te gebruiken en de antwoorden op te zoeken!

Verder wordt er na elke vraag gevraagd hoeveel mentale effort het je kostte om de vraag te beantwoorden.

K1 Welke twee componenten analyseer je voor de *recurrente* vaardigheden?

A. Cognitieve regels en prerequisite kennis
B. Cognitieve strategieën en prerequisite kennis
C. Weet ik niet

K2 Een *rule-based* analyse wordt aangeraden uit te voeren in situaties waarbij:

A. De stappen op volgorde van tijd moeten worden genomen
B. De stappen niet op volgorde van tijd moeten worden genomen
C. Weet ik niet

K3 In sommige gevallen zijn er meerdere IF-THEN regels die van toepassing zijn op een situatie en moet er een regel boven een andere gekozen worden. Dit past bij het begrip:

A. Conflict resolution
B. Flowchart
C. Weet ik niet

K4. Bij welke strategie wordt een *flowchart* gebruikt?

A. Rule-base analysis
B. Information processing analysis
C. Weet ik niet

K5. Stelling: prerequisite kennis hoef je alleen te analyseren voor part-task practice.

A. Waar
B. Niet waar
C. Weet ik niet

K6. Feiten en fysieke modellen zijn een verdere analyse van:

A. Principes
B. Concepten
C. Weet ik niet

Herkenningsvragen

Lees eerst het volgende voorbeeld door.

Een educatief adviesbureau is ingehuurd om oudere mensen les te geven over het gebruik van digitale apparaten. Het team is nu bezig met het ontwerpen van lessen voor het gebruik van een iPad. Om een iPad te gebruiken zijn er *recurrente* vaardigheden nodig: vaardigheden die algemeen zijn in elke situatie min of meer hetzelfde worden toegepast. De volgende vragen gaan over de analyse van verschillende onderdelen van deze *recurrente* vaardigheden.

H1 Het team analyseert bepaalde standaard stappen in het gebruik van een iPad. Voorbeeld hiervan is: wanneer je een gemaakte foto wil bekijken, klik je het icoontje met het fotoalbum aan. Dit is een voorbeeld van:

A. Systematic Approach to Problem solving (SAPs)
B. Cognitieve regel
C. Weet ik niet

H2 Het team analyseert eerst de voorkennis die de ouderen nodig hebben voor het gebruiken van de iPads, en daarna de cognitieve regels die van toepassing zijn op deze voorkennis. Stelling: deze volgorde van analyseren is de juiste volgorde volgens het 4C/ID model.

A. Waar
B. Niet waar
C. Weet ik niet

H3 Het team ontdekt tijdens het geven van de lessen over de iPads dat sommige ouderen denken dat je eerst de iPad moet verbinden met het internet als je hem ontgrendelt. Dit is echter niet nodig. Deze situatie is een voorbeeld van het begrip:

A. Typical error/Malrule
B. Misconception
C. Weet ik niet

H4 Het team merkt dat veel stappen in het gebruik van een iPad op volgorde moeten gebeuren. Bijvoorbeeld, om een foto te maken, moet de iPad eerst ontgrendelt zijn, moet je het icoontje met de camera aanklikken en moet je op de rode knop klikken om de foto te maken. Voor het analyseren van dit soort regels heeft het team de volgende strategie nodig:

A. Rule-based analysis
B. **Information processing analysis**
C. Weet ik niet

H5 Tijdens het geven van de lessen ontdekt het team dat veel ouderen voorkennis missen. Bijvoorbeeld, sommige ouderen weten niet waarom het belangrijk is een wachtwoord in te stellen. Binnen de prerequisite kennis, zouden we dit aanduiden als:

A. Een concept
B. Een principe
C. Weet ik niet

H6 Tijdens de les komt er een oudere naar een docent toe en legt uit dat het hem niet lukt het internet opnieuw in te stellen. De docent ziet dat de oudere bij de instellingen van de bluetooth zoekt, in plaats van bij de wifi-instellingen. De docent komt erachter dat de docent niet goed het verschil tussen deze twee instellingen begrijpt. Dit kunnen we aanduiden als:

A. **Een misconception**
B. Een typical error/malrule
C. Weet ik niet

Mental effort

1. How much effort did it take you to understand the preceding information?
2. How much effort did it take you to answer the preceding question(s)?

Answer options:

1. *very, very low mental effort* (2) *very low mental effort* (3) *low mental effort* (4) *rather low mental effort* (5) *neither low nor high mental effort* (6) *rather high mental effort* (7) *high mental effort* (8) *very high mental effort* (9) *very, very high mental effort.*

Self-efficacy

1. I believe I will receive an excellent grade for this part of the course literature.
2. I'm certain I can understand the most difficult material presented in this theoretical part of this course.
3. I'm confident I can understand the basic concepts taught in this theoretical part of the course.
4. I'm confident I can understand the most complex material presented in this part of the literature.
5. I'm confident I can do an excellent job on the assignments and tests about this section of the literature.
6. I expect to do well in this session.
7. I'm certain I can master the skills being taught in this session.
8. Considering the difficulty of this course, the teacher, and my skills, I think I will do/did well in this session.

Answer options:

(1) *Not at all true for me* (2) *Not true for me* (3) *Somewhat not true for me* (4) *Neither not true nor true for me* (5) *Somewhat true for me* (6) *True for me* (7) *Very true for me.*