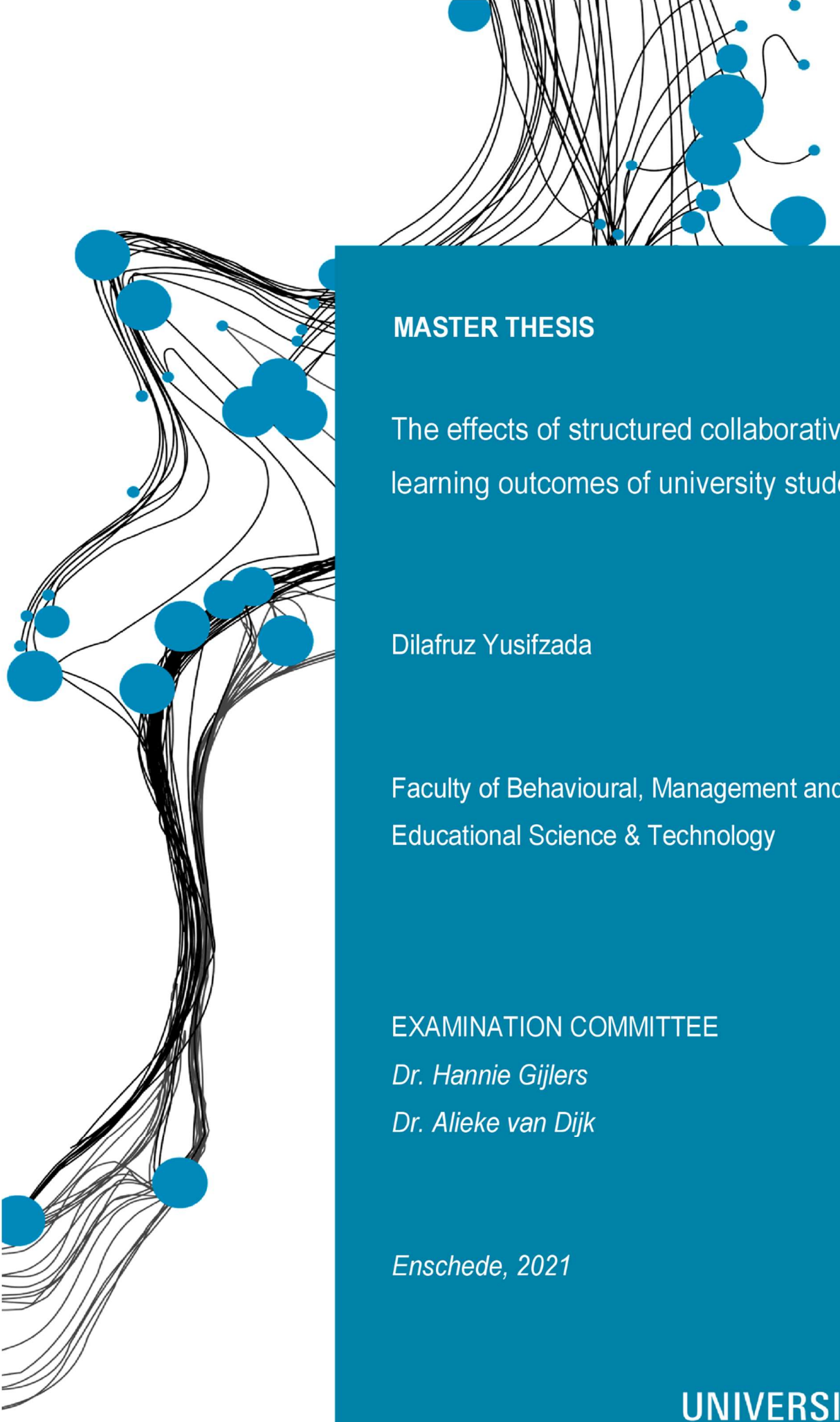

MASTER THESIS

The effects of structured collaborative learning on the learning outcomes of university students

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Abstract

Learning outcomes in collaborative learning can be improved by structuring the collaboration process while students are working together to produce a joint output. This study investigated the effects of collaboration scripts on students' learning outcomes and group work experience by conducting a group work experiment in two different manners. Jigsaw collaboration scripts were used to structure the group work. The research was conducted using an online learning environment (Graasp). Participants were 48, English speaking, university students aged over 16. They were randomly assigned to one of the two conditions, by making four participants in each group. Learning outcomes were measured in two ways: pre/post tests for the factual knowledge gain and concept maps made by students for the conceptual knowledge gain. The domain of the experiment was based on Piaget's theory of cognitive development. Findings from this study did not reveal any positive effect of structuring collaboration with Jigsaw scripts, regarding learning outcomes and group work experience. It suggests for future research to investigate different type of structuring, to add an interaction element to the learning environment to improve students' learning outcomes and their group work experience.

Keywords: *Collaborative learning, Structured collaboration, collaboration scripts, learning outcomes*

Introduction

Collaborative learning has been considered an effective methodology as it is believed that students learn more when they work together than alone (Kyndt et al., 2013). Collaborative learning is the instructional use of small groups so that students work together to maximize their own and each other's learning (Johnson, Johnson & Smith, 2006). In a collaborative learning situation, students work together in small groups to discuss and solve problems together (Tomcho & Foels, 2012). The studies which were conducted related to collaborative learning, mainly focuses on the advantages of working collaboratively in teaching and learning environment. Research on collaborative learning by So, Tan and Tay (2012) showed both positive learning results and a positive group learning experience from the learner's perspective. Effective collaboration, working effectively as a group, fosters the interpersonal skills of the learners. Head (2003) explains effective collaboration as a group of people behaving in a way that not only individual benefits are gained, but also it leads to a degree of success belonging to the group and can only be achieved by all group members working together in this manner. Race (2000) states that group learning results in a more enjoyable, sociable learning experience compared to individual learning. With successful group learning, all members help one another to get more feedback and achieve a goal together. In effective group activities, learners have higher learning outcomes, they receive better explanations of things they do not understand from other fellow learners (Johnson & Johnson, 2002).

Although there is an evident number of studies demonstrating the effectiveness of collaboration, it does not always work (Hertz-Lazarowitz & Miller, 1992; Hesse et al, 2015; Zambrano et al., 2019). Collaboration does not spontaneously occur when students are placed in groups and told to work together (Van Dijk et al, 2019; Wang, 2009). Hence, collaboration between students is not always successful, group work can be claimed to have many challenges. Stern and Huber (1997), Kirschner et al. (2009) claim that one of the difficulties students face is that they are more comfortable in a passive, individual roles rather than in an active group work. From Hartley and Dawson's (2010) point of view, some of the main challenges faced by students working in a group are communication, organization, and workload. Students need to listen and consider each other's opinions. Furthermore, group members need to organize the time and workload to be able to finish the task properly. However, according to Hartley and Dawson (2010), "one of the most common complaints from students about group work is that some group members are not participating or contributing enough to the project" (p. 11). Race (2000) indicates that some

learners feel like they are competing with each other in the group work process and it causes ineffective collaboration.

When students are not guided in their collaboration process, the group work becomes ineffective (Saab, Van Joolingen & Van Hout-Wolters, 2007). Ineffective collaboration can lead to social loafing, meaning that students are not participating or contributing equally (Veenman, Kenter & Post, 2000). Some students might not even participate in the group process at all, again leading to social loafing (Veernman et al., 2000). In unstructured or unguided collaboration, students decide for themselves how they work together (Saleh et al., 2007). In this case, some of the main elements of effective collaboration such as individual accountability and positive interdependence are not guaranteed, meaning that not all students feel their individual contribution is valued and necessary to finish the group task or they do not feel linked to the other members of the group and do not believe that their individual success maximises when the other members of the group succeed (Johnson & Johnson, 2002), and it makes the social loafing possible to occur.

Many studies have been conducted to understand how to make the group learning more effective (Brindley et al., 2009; Smith, 1995; Wilson et al, 2007). One of the possible solutions is that teachers need to structure and guide the collaboration process to overcome this problem. Collaborative learning is neither a methodology, nor mechanism, but rather, a learning situation where the desired patterns of interaction can only occur by structuring the collaboration process (Dillenbourg, 1999; Dittman et al., 2010). Gillies (2003) demonstrated the importance of structuring small group learning in classrooms by highlighting that students attain higher academic outcomes and are more motivated compared to working individually. Oflaz and Turunc (2012), Webb (1989), Biott (1987), Puntambekar (2006), Van Dijk et al (2019) also strongly advocate the need to develop a structured approach to group work, emphasizing especially the shared understanding between the students regarding group activity.

Different types of activities can be used to structure and scaffold the collaboration of the students (Persico & Pozzi, 2011). One of the instructional methods to structure the group work is the use of collaboration scripts (Kobbe et al., 2007). Scripting can be done by guiding the participants through a sequence of phases during the group work with assigned roles and activities (Kobbe et al., 2007). For instance, Jigsaw scripting is one of the useful techniques to develop collaboration and minimize the differences (cultural, cognitive, social, etc.) between students

(Atmatzidou & Demetriadis, 2012). This type of script is based on segmenting the learning content into complementary parts and assigning each part to a group of learners (Persico & Pozzi, 2011). Jigsaw technique to script collaboration is mainly used in face-to-face settings without computer support (Gallardo et al, 2002). Application of this technique results in better understanding of the subject taught and the higher performance of the students (Atmatzidou & Demetriadis, 2012).

While all collaboration scripts aim at promoting desired learning outcomes and student interactions (Kobbe et al., 2007), not many studies (Hummel et al., 2013) have investigated the different effects of face-to-face and online scripted collaboration. Moreover, there is little empirical evidence to indicate whether the positive effects of structured collaboration on achievements in face-to-face settings transfer to online environments where collaboration and communication is mediated by computers (Hara, 2002; Joung, 2003). Therefore, purpose of this study is to investigate the effects of structuring collaborative learning activities by means of Jigsaw collaboration scripts on learning outcomes and group work experience of university students in an online setting. This study will explore whether structuring group work with modified Jigsaw scripts has a positive impact on both students' learning outcomes (knowledge gain) and their group work experience.

Theoretical Framework

Learning outcomes of collaborative group work

Collaboration skills influence students' learning outcomes (Johnson & Johnson, 1999, 2002; Le, Janssen & Wubbels, 2018; Mercer et al., 2004 & Ross, 2008). Numerous positive results are shown in the success of collaborative learning as a tool to increase students' learning outcomes (Laal & Ghodsi, 2012; Lou et al, 1996; Kyndt et al., 2013; Astra et al., 2015).

Research agrees that students who collaborate with peers achieve higher learning gains than students who learn individually (Manlove, Lazonder & De Jong, 2009). Lazonder (2005) examined how effective either pairs of students or individual students conducted web searches and the results showed that pairs outperformed individual students. Pairs also outperformed individual students in another study conducted on online inquiry learning environment by Manlove et al. (2009).

Previous research on structured and unstructured collaboration implies a positive effect of structured collaboration on students' learning gains (Saleh et al., 2007). Structuring the

collaboration process by using scripts leads to higher learning gains than collaboration without a script (Weinberger et al., 2005). The research conducted by Aslan (2015) investigated the difference between unstructured and structured collaboration of the students. Her study found out that students' interactions are more effective in structured collaborative learning and it leads to higher learning gains and a more positive learning experience. In this study, collaboration will be structured online with Jigsaw scripts by dividing the task into segments and assigning each part to one group member,

Collaborative learning

Collaborative learning is defined as students working together to solve a problem or complete an assignment (Saab et al., 2007). In collaborative learning environments students work together, respect each other's inputs and they are encouraged to achieve common learning goals together (Macaro, 1997). The main idea behind collaborative learning is that learning is based on socially structured exchange of information between group members, meaning that learners have the opportunity to converse with peers, present and defend ideas, exchange diverse beliefs, question other conceptual frameworks (Srinivas, 2011) and in certain type of collaborative learning (e.g., Jigsaw) every person is responsible for his or her learning as well as motivating to increase each other's learning. Collaboration with peers scaffolds the learning process (Khan, 2001). For instance, students can learn from each other and elaborate on each other's ideas in jigsaw supported collaboration environment (Gillies, 2004). Through collaboration with peers, students experience that their own point of view is not the only way to approach a problem and that together they can achieve more than alone (Johnson & Johnson, 2002).

Collaborative learning has some advantages stated by Flynn and Hill (2006) compared to individual learning such as working together on a task is usually more pleasant than working alone. Different views can extend the horizon of the learners. Students with various background knowledge can work together and exchange their knowledge. Problems can be solved more efficiently when learners collaborate (Hesse et al., 2015). Problem is identified as a discrepancy between current state and goal state, and collaborative problem solving can be defined as a joint activity where groups execute several steps to transform a current state into a desired goal state by working together and exchanging ideas (Hesse et al., 2015). Collaborative learning provides many cognitive advantages to learners (Vygotzky, 1978; Bossert, 1988; Fischer et al., 2007), it increases

the learners' problem-solving skills (Kulik & Kulik, 1979; Bennett & Dunne, 1992; Lazakidou & Retalis, 2010), facilitates learners' critical thinking (Smith et al., 2009) and encourages reflection (Tao & Gunstone, 1999).

However, collaboration between students only has a positive effect on student learning under certain conditions (Dillenbourg et al., 1996; Janssen et al., 2007). These five conditions are individual accountability, positive interdependence (Felder & Brent, 2007), promotive interaction, interpersonal group skills and group processing (Johnson et al, 2007). Felder & Brent (2007) especially stress the importance of individual accountability and positive interdependence when students work as a group, in order to avoid social loafing, namely, not all students participating equally. Individual accountability means that every group member is actively responsible for their own contribution to the group work (Astuti & Lammers, 2017). Positive interdependence means that group members need each other to complete the task and reach their goals together (Johnson et al., 2007).

Structured collaborative learning

Johnson, Johnson and Smith (2007) suggest that aforementioned five essential elements in each group work have to be structured for the collaboration to be effective. Webb (2009), Johnson and Johnson (1988) claim that "having students work in a group" and "structuring students to work collaboratively" are noticeably different from each other. If students only sit around the table and talk freely while working, this means they are not structured to be a group and work collaboratively due to the lack of positive interdependence (Scager et al., 2016). They state, "putting students into groups does not necessarily gain positive interdependence and/or individual accountability; it has to be structured and managed by the teacher or professor" (Johnson & Johnson, 1988, p.35; Johnson & Johnson, 2009).

Ning (2013) and Weinberger, Ertl, Fischer, and Mandl (2005) stress the importance of equal participation and interaction between collaborating students. Task can be structured and the collaboration process can be scaffolded to ensure that desired patterns of interaction and participation occur by giving students specific roles or by means of collaboration scripts (Dillenbourg, 1999; Kollar, Fischer & Slotta, 2007; Weinberger et al., 2005). Barron's (2003) research stresses the importance of transactivity, known as students relating to each other's contributions to collaborate successfully and to benefit from the collective knowledge of the group

(Hong et al., 2015). In order to achieve this, students need guidance and structure both in their learning process and also in their collaboration process. Collaboration can be structured by giving students specific roles or imposing specific interaction patterns, such as all group members sharing their opinion at a certain phase of the group work (Dillenbourg, 1999).

The use of collaboration scripts is also an effective strategy to structure collaboration (Kollar et al., 2007). Scripts are detailed instructions on how the students should collaborate, which steps the students should take in their collaboration process (Dillenbourg, 2002). Collaboration scripts are scaffolds that aim to improve collaboration through structuring the interactive processes between two or more learning partners. Collaboration scripts have been used to structure both face-to-face (e.g., O'Donnell & Dansereau, 1992; Palincsar & Brown, 1984) and computer-mediated collaboration (e.g., Dillenbourg, 2002; Rummel & Spada, 2005; Weinberger et al., 2005).

Many scripts use a variation of the Jigsaw method (Aronson et al. 1978). The Jigsaw script is extensively used in face-to-face collaborative learning (Persico & Pozzi, 2011) and is nowadays also popular in online learning (Blocher, 2005). The script is based on segmenting the learning content into complementary parts and assigning each part to a group of learners (Persico & Pozzi, 2011). These groups are called the "expert groups", who study and analyze the assigning part and become expert in it (Papasalouros & Chatzimichalis, 2020). Following this phase, new groups are formed, these groups are called "jigsaw groups" and contain one member from each "expert group". In "Jigsaw groups", students discuss what they learnt and share about their expertise (Papasalouros & Chatzimichalis, 2020). The overall aim of this scripting is to build up a complete vision of the problem, encourage students to produce a joint output and increase individual involvement in the group work (Kerr & Bruun, 1983).

According to Schank and Abelson (1977), scripts enhance both understanding and recall (on an individual level; e.g., Nuthall, 2000) and promote the coordination of activities in a particular situation (on a group level). Similarly, collaboration scripts are goal-oriented in the sense that specific approaches help learners engage in smooth collaboration processes and reach specific (learning) objectives. Collaboration scripts specify and distribute roles among the participating individuals (Kollar, Fischer, & Hesse, 2006). Distributing collaboration roles helps support the collaborating partners in approaching the task from multiple perspectives. This, in turn, helps learners consider problems from various viewpoints (Spiro et al, 1991; Yasmin et al., 2019).

The main idea behind the structuring group work with collaboration scripts is that it leads to successful group activities including collaborative interaction and better group performance (O'Donnell & Dansereau, 1992), it is an effective approach to promote learning in both face-to-face and online contexts (King, 2007). Therefore, teachers and researchers have developed different scripts to structure and regulate the collaboration in group work processes so that learners are interacting in ways appropriate to the learning task. (Gillies, Ashman & Terwel, 2008).

Structuring the collaboration process is expected to lead better learning gains, this can be visible student's recall in knowledge on the lesson content, such as declarative knowledge gain. Schraw, Crippen and Hartley (2006) claim that collaborating with peers helps students to increase their declarative knowledge, because students learn from each other. Declarative knowledge in education refers to recalling facts, definitions, and concepts (AbuZaid & Khan, 2013). Students need declarative knowledge to learn and understand new concepts. A study on the effect of collaborative learning by Sung and Hwang (2013) demonstrated the positive effect of collaborative learning on student's declarative knowledge gain.

In this study, students' declarative knowledge gain is measured by pre-post knowledge tests and concept maps scores. Therefore, declarative knowledge gain will be conceptualized by departing it into factual and conceptual knowledge. Factual knowledge can be described as the basic information about a particular subject or discipline that student must be acquainted with to be able to solve a problem. However, conceptual knowledge refers to the patterns and interrelationships among the elements within a larger structure that enable them to function together.

Research questions and model

The main aim of this research is to shed light on the effectiveness of structured group work with collaboration scripts by means of the following questions:

1. Does structured group work with collaboration scripts yield better learning outcomes than unstructured group work in terms of increased factual and conceptual knowledge gain for university students?

2. Do the students who participate in structured group work with collaboration scripts perceive their collaborative learning experiences more positively than the students participating in unstructured group work?

The research questions lead to these hypotheses:

1. Structuring group work will have a positive influence on students' learning outcomes. It will lead to a better recall of declarative knowledge, specifically, increased factual and conceptual knowledge gain compared to students in unstructured group work.

2. Structuring the group work will decrease social loafing in collaboration process and therefore, students will perceive their group work experience more positively compared to students in the unstructured condition.

Research design and methods

Research design

An online experimental study was conducted, meaning that students were randomly put into two experimental conditions: structured and unstructured group work. Each group consisted of 4 students in both conditions. The students in structured condition received a scripted instruction explaining each student their specific role in the assignment and the sequence of the activities. The main aim of the study was to gain insight in how knowledge gain and group work experience of the students is different in these two conditions. The independent variables in this study were structured and unstructured collaboration. Students' factual knowledge gain was measured with pre-post knowledge tests, conceptual knowledge gain was measured with the concepts used in the concept maps created by students. Students' group work experience was measured by a Likert scale questionnaire.

Respondents

48 students from various backgrounds, degrees, and countries between the age of 17 and 34 participated in the study (38 females, 10 males; M(age) = 22, SD = 3.724). Students signed up online for the experiment and were randomly assigned to each group by computer. Each group consisted of four students, making in total 12 groups. six groups (24 students) were randomly assigned to structured (17 Female, 7 Male; M(age) = 23, SD = 4.096) and six groups (24 students) to unstructured collaboration conditions (21 Female, 3 Male; M(age) = 22, SD = 3.294).

Participation was on a voluntary basis. The consent of the participants was gathered prior to the study via an online informed consent form in the learning environment Graasp when they entered. This form can be found in Appendix 1.

Domain

An experiment was conducted in an online learning environment, Graasp. The domain of the learning and assessment materials used in the experiment was based on the topic of Piaget's theory of cognitive development. The topic was considered relevant based on participants age and interests.

Instrumentation

Learning materials

Collaboration scripts

Students in the structured condition received scripted instruction during the experiment in which the sequence of activities and the task division were explained, also they were assigned only one segment of the task. An example instruction prior to the collaboration task (only structured condition) – "In this part of the experiment you will create a concept map about the stages of cognitive development based on Piaget's theory together with three other participants. Each participant has watched a video about one particular stage." The video which participants had to watch to be able to do the task was segmented into four parts and each part was assigned to one student. The script highlighted and explained the division of the responsibility of the task and the video watching by assigning each stage of the topic to a separate member. This is a modified version of Jigsaw scripting, by replacing "expert" and "jigsaw groups" with single participants. An example scripted instruction screenshot from the online learning environment Graasp can be found in Appendix 6.

Whiteboard animation video

A whiteboard animation video about Piaget's theory of cognitive development taken from YouTube was used in the experiment as a part of intervention. The video (Piaget's Theory of Cognitive Development - YouTube) explained the four stages of the Cognitive Development in a whiteboard animation style, by images being drawn on the screen and illustrations accompanied by a narration about the topic. The video material used differently in two conditions. The six-minute video was fully presented in the unstructured collaboration condition. However, it was

divided into four segments (clips) for the structured condition as each segment was dedicated to the explanation of one cognitive stage. Each segment was around 90-100 seconds. An example screenshot from the video can be found in Appendix 2.

Concept map

The group task in both conditions was to create a concept map together about Piaget's stages of cognitive development. The concept map tool in the learning environment allowed students to work online at the same time and create a concept map together. The instructions on how to use the tool, how to create a concept map and what is a concept map were explained above the task (see Appendix 7). These concept maps allowed to measure and compare the conceptual knowledge gain of the students about the topic taught in the video. Example concept maps created by the students in two different conditions can be found in Appendix 8 and 9.

Assessment materials

Knowledge tests

Two tests were designed to measure student's factual knowledge gain, one as pre and one as post-test. Nine multiple-choice questions about the topic (Piaget's theory of cognitive development) were included in each test. The questions were based on the stages of cognitive development taught in the video. "In which stage the typical age range extends from about seven to eleven years?" is an example questionnaire item. These tests allowed to measure and compare the factual knowledge gain of the students in these two conditions. These tests can be found in Appendix 3 and 4.

Cronbach's α was measured to check the reliability of the constructs for both tests. The relatability analysis of the data obtained from the pre-test indicated poor internal consistency of the test items. Cronbach's $\alpha = .56$, 9 items. The reliability analysis of the data obtained from the post-test indicated adequate internal consistency of the test items. Cronbach's $\alpha = .78$, 9 items.

Collaboration experience questionnaire

To measure the effect of structuring group work on collaboration experience of the students, a questionnaire with five statements were prepared by the researcher. The answers were presented in 5-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). An example item from the questionnaire is "This group assignment gave me a chance to learn from my peers'

contribution". The scores were calculated in the range of 1-5 respectively. This questionnaire can be found in Appendix 5.

Cronbach's α was measured to check the reliability of the constructs. The reliability analysis revealed a Cronbach's α score of .87 of the 5 items.

Procedure

The Ethical Committee Approval was applied to get prior to the data collection. The experiment was held in an online learning environment – Graasp. Students digitally entered the environment with a number randomly assigned to them based on their condition, here they were first informed about the details of the study and asked for their consent before they proceed. Respondents answered a few demographic questions (gender, age etc.) after virtually signing the consent form. Later they were directed to do the pre knowledge test and then watch a video about Piaget's theory of cognitive development. After watching the video, the main task, creating a concept map about the topic, was done by the students. In the next stage, the post knowledge test was required to complete. Finally, students filled in the group work experience questionnaire and were thanked to participate in the experiment. The overall experiment took one hour, however, specification of time spent on each stage varies per group. For instance, in structured condition, video watching took 1.5-2 minutes per student, in unstructured condition 6 minutes. The main difference between conditions was the division of the task and workload. In unstructured condition, every participant received the full task, not one segment of it.

Data analysis

The quantitative data was collected from pre/post-tests, concept maps and the Likert scale questionnaire. To test for normality of distribution Shapiro Wilk test was used. For all analyses, testing was two-tailed with alpha set at 0.05 and was used to report on significance.

Knowledge tests

These pre and post-tests measured students' factual knowledge gain were scored based on their correct responses to the multiple-choice questions. The multiple-choice questions accounted for one point each, culminating to a total of maximum of nine points in each test. Students could obtain a maximum of nine and minimum of zero points on each test. The difference between post and pre-test was also calculated per student. The assumptions on the normality of distribution were tested and Shapiro Wilk test revealed that the pre test scores and difference scores per condition

were normally distributed, however, there were violations for normality of post test scores. An independent samples t-test was conducted to compare the difference mean scores of the students in both conditions.

Concept map scores

The scores were obtained based on the concepts added in the concept maps created by students, it measured students' conceptual knowledge gain. It was checked and evaluated based on the 59 statements in the codebook. Each concept map could score minimum zero, maximum fifty-nine points. The scores turned out to be non-normally distributed based on Shapiro Wilk test. Mann Whitney U test was conducted to compare the mean scores of students in both conditions.

Codebook

A codebook was created by the researcher to check the quality of the concept maps. In order to create the codebook, the researcher student listened to the video used for experiment, transcribed it and made an example concept map to cover all the concepts mentioned in the video. The concept maps created both by the researcher and the students contain concepts and the links between concepts. While preparing the statements of the codebook, the meaning attained both from concepts and the links were taken into account. The final version of the codebook (statements) was checked and confirmed by the supervisor psychologist Hannie Gijlers. The codebook included 59 statements about the topic (Piaget's stages of cognitive development) in different categories such as general, or per specific cognitive stage, and explained the point system given to each statement in the concept maps created by students. If the statement is explicitly written/explained on the concept map, the student gets 1 full point, if some part of the statement is implicitly mentioned, it gets 0.5 points. If there is no information about certain statement, the concept map gets 0 point for that statement. In total minimum 0, maximum 59 points could be scored. An example part of one concept map is shown in Figure 1. In this part of the concept map, an example statement based on the relevant stage in the codebook like "development of working memory" is explicitly explained, therefore, this concept map gets 1 full point fort that statement. The codebook can be found in Appendix 10.

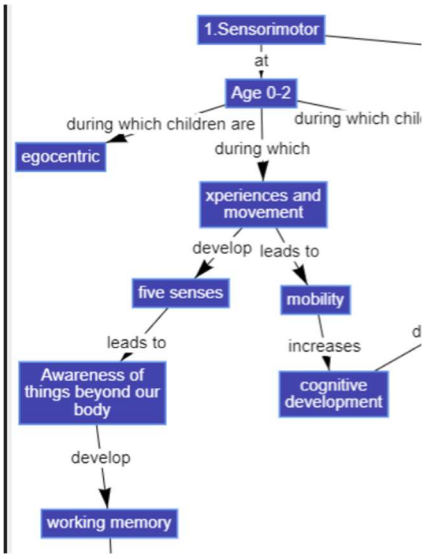


Figure 1. Example part of one concept map

Collaboration experience questionnaire

Students' responses on the questionnaire ranged between five options – Strongly Disagree, Disagree, Neutral, Agree and Strongly Agree. The scores were calculated in the range of 1-5 respectively and measured student's group work experience. The total scores ranged between 5-25. A higher score on the questionnaire indicated a more positive collaboration experience, whereas a lower score indicated that students did not perceive their group collaboration very positively. The assumptions on the normality of distribution were tested and Shapiro Wilk test revealed that responses were not normally distributed. Means scores between the structured and unstructured conditions were compared by Mann Whitney U test.

Results

This chapter comprises analysis of results. The data will be presented starting with participants' scores distribution, followed by the data regarding the differences in their factual knowledge gain, conceptual knowledge gain and collaboration experience.

Distribution of quantitative scores

The effect of structured or unstructured collaboration on factual knowledge gain was measured by pre and post-tests, effect on conceptual knowledge gain was measured with the data obtained from

concept maps, and students' collaboration in both conditions was measured via a questionnaire. Table 1 displays the mean and standard deviations of these quantitative scores for both conditions.

Table 1

Descriptive statistics of the quantitative scores

Test scores	Mean (*Standard* Deviation*)*		
	Structured Group	Unstructured Group	Total
	(n = 24)	*(n = 24)*	*(n = 48)*
Pre-test	3.67 (*1.69)*	3.63 (*2.14)*	3.65 (*1.91)*
Post-test	3.13 (*0.68)*	3.42 (*0.88)*	3.27 (*.79)*
Difference Pre-Test and Post-Test	-.54 (1.61*)*	-.21 (*2.40)*	-.37 (*2.03)*
Concept map scores	41.50 *(16.30)*	45.33 (*4.36)*	43.42 (*11.96)*
Group experience scores	16.54 (*4.24)*	16.08 (*5.38)*	16.31 (*4.80)*

Differences between conditions in factual knowledge gain

An independent samples t-test was conducted to compare factual knowledge gain, namely difference between post and pre-test score, in structured and unstructured conditions. There was not a significant difference in the score differences for structured and unstructured conditions; t(46)= -.57, p= 0.575. These results suggest that structuring group work does not have an effect on the factual knowledge gain of students.

Differences between conditions in conceptual knowledge gain

To evaluate the difference between structured and unstructured condition for conceptual knowledge gain, Mann Whitney U test was conducted. The test revealed insignificant differences for conceptual knowledge gain between the structured (Median= 43, n= 24) and unstructured (Median= 44.50, n= 24) conditions, $U = 288.000$, z = .000, p = 1.000, r = 0.00.

Differences between conditions in collaboration experience

To identify if there is a difference for collaboration experience between structured and unstructured conditions, Mann Whitney U test was conducted. The test revealed insignificant differences in collaboration experience between the structured (Median= 16.50, n= 24) and unstructured (Median= 18, n= 24) conditions, $U = 279.000$, z = -.186, p = .852, r = 0.03.

Discussion

The purpose of this study was to investigate the effects of structured collaboration with Jigsaw scripts on the learning outcomes and group work experience of university students in an online setting. The first research question to answer was "Does structured group work with Jigsaw collaboration scripts yield better learning outcomes than unstructured group work in terms of factual and conceptual knowledge gain?". It was hypothesized that structuring group work will have a positive influence on students' learning outcomes. It will lead to a better recall of declarative knowledge, specifically, increased factual and conceptual knowledge gain compared to students in unstructured group work.

No effect of structuring the collaboration process both on factual and conceptual knowledge gain was found. Students in structured and unstructured conditions had similar learning outcomes regarding both factual and conceptual knowledge gain. Learning outcomes in terms of factual knowledge gain for both conditions can be considered below average, however, regarding conceptual knowledge gain, students in both conditions scored above average. The results of this study are not consistent with most studies on structured and unstructured collaboration found in the literature. The findings of this study are not in line with previous research conducted by Weinberger et al. (2005), as using scripts did not lead to better learning gains. The potential reason behind this can be lack of social interaction between participants. Unlike Weinberger et al.'s study (2005), during this experiment, in digital environment, students did not see or talk to each other. Research done by Saleh et al. (2007) and Aslan (2015) showed higher learning gains in the structured collaboration groups. It is important to consider that these studies were performed with upper elementary school students and this raises a question that whether the effects of structuring collaboration are different for elder, university students as in this study. Experiments done by Liu et al. (2010) also claim that there is an association between student's age and their group work

experience, perception of the group work. Therefore, students' negative group work experience might have an effect on their learning outcomes.

Moreover, collaboration depends on time, effort and trust among peers (Weinberger et al., 2007). Without social interaction, it might be hard to build trust between participants. Especially in this aspect, the short-term nature of this collaboration in an online setting also played an important role. Building trust in an online environment that promotes collaboration requires long term interaction. However, this was a one time, an hour limited experiment session. Working online can take more time, therefore, the necessary effect to gain the knowledge may be obtained in a longer run compared to face-to-face structured collaboration environments.

The second research question was "Do the students who participate in structured group work with collaboration scripts perceive their collaborative learning experiences more positively than the students participating in unstructured group work?". It was hypothesized that structuring the group work will decrease social loafing in collaboration process and therefore, students will perceive their group work experience more positively compared to students in the unstructured condition. Based on the results of this study, the hypothesis was not accepted. No difference was observed between the means scores of the students in structured and unstructured condition. Potential reason behind this could be that poor sense of physical presence and limited non-verbal communication, as in this study, have been pointed out by several authors (e.g., Irani et al., 2008) as a shortcoming of effective group work experience. Participants not being able to discuss the task verbally might have affected their group work experience negatively. Another potential reason behind this could be the role of user experience with technology. Since experiment was online and conducted in a new and unknown learning environment to students, poor user experience, lack of necessary technological skills might have caused extra cognitive load, therefore, participants might not have had positive group work experience as expected.

Additionally, there are several limitations to this research. First, the study had a small sample size of 48 participants. For the statistical analysis, a larger sample size would have allowed to make more solid inferences about the population. Therefore, generalization of the results about all students cannot be done based on this study. Another limitation was that the participants were divided into groups randomly, not based on their pre-knowledge about the topic, it might have influenced the results. Participants with higher pre-knowledge could do the task more easily and

have more positive group experience, however, it might not lead to higher knowledge gain. Moreover, those participants being in the same group with students having zero pre-knowledge could negatively affect the group experience regarding students' self-confidence and certainty about the topic or task. Future research could make the groups based on participants' pre knowledge about the topic, so that the knowledge gain per group before and after intervention in each condition would be more visible. Moreover, the online learning environment (Graasp) might have been new for some students, a small pre-training about the concept mapping tool before the experiment could allow to improve the user experience and affect the collaboration process.

For future research, it would be interesting to add certain elements as an interaction function to the experiment such as video talk, chatting option which was missing in this study. Qualitative data could be collected to measure whether students perform better while engaging in a transactive talk, discussing verbally and getting involved in the task more. Also, different type of scripting can be used to find out which collaboration scripts are more effective for structuring the group work. Kollar et al. (2007) explains that scripts vary in their degree of structuredness, therefore, more research is necessary to look out what kind of structuring can be more effective for better learning outcomes and more positive group work experience.

Overall, information and communication technologies has established new opportunities to participate in online learning environments around the globe. This allows participants to connect to online learning environments from distant locations like in this study. However, these digital learning experiences create potential challenges too (Weinberger et al., 2007). This study investigated further understanding of learners' interaction with two different types of group work in online learning environment. The results could be informative for the practitioners, educators to structure the group work of their students in daily practices. Moreover, the findings of the topic might provide insight for considering the need for raising awareness of importance of collaborative learning in an online setting and how to make it more effective. The study highlights the understanding of how group work could be structured, what effects of such structuring on learning outcomes and group experience in an online environment could be expected.

References

Abu-Zaid, A., & Khan, T. A. (2013). Assessing declarative and procedural knowledge using multiple-choice questions. *Medical Education Online, 18*(1), doi: 10.3402/meo.v18i0.21132

Aronson, E., Blaney, N., Stephan, C., Sikes, J., & Snapp, M. (1978). *The jigsaw classroom*. Thousand Oaks, CA: Sage Publications.

Aslan, A. (2015). *An experimental study into the effects of structured group work on students' collaborative behaviours and group performances* (Master's thesis), Hacettepe University, Ankara, Turkey.

Astra, I., Wahyuni, C. & Nasbey, H. (2015). Improvement of learning process and learning outcomes in physics learning by using collaborative learning model of group investigation at high school (grade X, SMAN 14 Jakarta). *J. of Educ. and Practice, 6*(11), 75-79.

Astuti, P., & Lammers, J. C. (2017). Individual accountability in cooperative learning: More opportunities to produce spoken English. *Indonesian Journal of Applied Linguistics, 7*(1), 215–229. https://doi.org/10.17509/ijal.v7i1.6878

Atmatzidou, S. & S. Demetriadis. *Evaluating the role of collaboration scripts as group guiding tools in activities of eduational robotics*. in *2012 12th IEEE International Conference on Advanced Learning Technologies.* 2012. Rome, Italy: IEEE Computer Society

Barron, B. (2003). When Smart Groups Fail. *The Journal of the Learning Sciences, 12*(3), 307-359.

Bennett, N., & Dunne, E. (1992). *Managing classroom groups*. New York: Simon & Schuster Education.

Biott, C (1987) Cooperative group work: pupil's and teachers' membership and participation, *Curriculum, 8*(2), 5-14.

Blocher, J.M. (2005). Increasing learner interaction: using jigsaw online. *Educational Media International, 42*(3), 269-278.

Bossert, S. T. (1988). Cooperative activities in the classroom. *Review of Research in Education*, 225-250.

Brindley, J., Blaschke, L. & Walti, C. (2009). Creating Effective Collaborative Learning Groups in an Online Environment. *International Review of Research in Open and Distributed Learning, 10* (3). https://doi.org/10.19173/irrodl.v10i3.675

Dillenbourg, P., Baker, M., Blaye, A., & O'Malley, C. (1996). The evolution of research on collaborative learning. In E. Spada & P. Reiman (Eds.), *Learning in humans and machine: Towards an interdisciplinary learning science* (pp. 189-211). Oxford, UK: Elsevier.

Dillenbourg, P. (1999). What do you mean by 'collaborative learning'? In P. Dillenbourg (Ed.), *Collaborative-learning: Cognitive and computational approaches.* (pp.1-19). Oxford: Elsevier.

Dillenbourg, P. (2002). Over-scripting CSCL: The risks of blending collaborative learning with instructional design. In: Kirschner, P.A. (ed.), *Three worlds of CSCL. Can we support CSCL.* Open Universiteit Nederland, Heerlen, pp. 61–91.

Dittman, D., Hawkes, M., Deokar, A., & Sarnikar, S. (2010). Improving virtual team collaboration outcomes through collaboration process structuring. *The Quarterly Review of Distance Education, 11*, 195–209.

Felder, R. M., & Brent, R. (2007). Cooperative learning. In P. A. Mabrouk (Ed.), *Active learning* (pp. 34-53). Washington, DC: American Chemical Society.

Fischer, F., Kollar, I., Mandl, H., & Haake, J. (eds.). (2007). *Scripting computer-supported collaborative learning: Cognitive, computational and educational perspectives*. New York: Springer.

Flynn, K., & Hill, J. D. (2006). Classroom instruction that works with English language learners. *Association for Supervision and Curriculum Development*. Virginia: Alexandria

Gallardo, T., Guerrero, L.A., Collazos, C., Pino, J.A., & Ochoa, S. (2003). Supporting JIGSAW-type Collaborative Learning. *System Sciences*, (p. 8). Hawaii.

Gillies, R. M. (2003). Structuring cooperative group work in classrooms. *International Journal of Educational Research, 39*(1), 35-49.

Gillies, R. M. (2004). The effects of cooperative learning on junior high school students during small-group learning. *Learning and Instruction, 14*(2), 197–213.

Gillies, R. M., Ashman, A. F., & Terwel, J. (Eds.). (2008). *The teacher's role in implementing cooperative learning in the classroom* (Vol. 8). New York: Springer.

Gunawardena, C. N., Carabajal, K., & Lowe, C. A. (2001). *Critical analysis of models and methods used to evaluate online learning networks.* Paper presented at the annual meeting of the American Educational Research Association, Seattle, WA.

Hara, N. (2002). Analysis of computer-mediated communication: Using formal concept analysis as a visualizing methodology. *Journal of Educational Computing Research, 26*(1), 25–49.

Hartley, P., & Dawson, M. (2010). *Success in Groupwork*. Palgrave Macmillan.

Head, G. (2003). Effective collaboration: Deep collaboration as an essential element of the learning process. *Journal of Educational Inquiry, 4*(2), 47–62.

Hertz-Lazarowitz, R., & Miller, N. (Eds.). (1992). *Interaction in cooperative groups: The theoretical anatomy of group learning*. Cambridge University Press.

Hesse, F., Care, E., Buder, J., Sassenberg, K., & Griffin, P. (2015). A framework for teachable collaborative problem-solving skills. In P. Griffin & E. Care (Eds.), *Assessment and teaching of 21st century skills: Methods and approach* (pp. 37–56). Dordrecht, the Netherlands: Springer.

Hong, H. Y., Chai, C.S. & Tsai, C. C. (2015). College Students Constructing Collective Knowledge of Natural Science History in a Collaborative Knowledge Building Community. *J Sci Educ Technol, 24*, 549–561. https://doi.org/10.1007/s10956-015-9546-8

Hummel, H., Geerts, W., Slootmaker, A., Kuipers, D., & Westera, W. (2013). Collaboration scripts for mastership skills: online game about classroom dilemmas in teacher education. *Interactive Learning Environments, 23*(6), pp. 670-682.

Irani, L., Hayes, G.R., and Dourish, P. (2008). *Situated practices of looking: visual practice in an online world.* In: Proceedings: CSCW 2008. ACM Press, New York, pp. 187–197.

Janssen, J., Erkens, G., Kanselaar, G., & Jaspers, J. (2007). Visualization of participation: Does it contribute to successful computer-supported collaborative learning? *Computers & Education, 49*(4), 1037–1065.

Järvelä, S., Volet, S. and Järvenoja, H. 2010. Research on motivation in collaborative learning: Moving beyond the cognitive-situative divide and combining individual and social processes. *Educational Psychologist*, *45*(1): 15–27. doi:10.1080/00461520903433539

Johnson, D. W. (1991). Cooperative learning: Increasing college faculty instructional productivity. *ASHE-ERIC Higher Education Reports, 4*, George Washington University, One Dupont Circle.

Johnson, D. W., & Johnson, R. T. (1988). Cooperative learning: Two heads learn better than one. *Transforming Education*. 34-39.

Johnson, D. W., Johnson, R. T., & Smith, K. A. (1991). *Active learning: Cooperation in the college classroom*. Edina, MN: Interaction Book Company.

Johnson, D. W., & Johnson, R. T. (1999). Making cooperative learning work. *Theory into practice, 38*(2), 67-73.

Johnson, D. W., & Johnson, R. T. (2002). Learning together and alone: Overview and meta-analysis. *Asia Pacific Journal of Education, 22*(1), 95-105.

Johnson, D. W., Johnson, R., & Smith, K. (2006). *Active learning: Cooperation in the university classroom* (3rd ed.). Edina, MN: Interaction.

Johnson, D. W., Johnson, R. T., & Smith, K. (2007). The State of Cooperative Learning in Postsecondary and Professional Settings. *Educational Psychology Review*, *19*(1), 15–29.

Johnson DW, Johnson RT (2009). An educational psychology success story: social interdependence theory and cooperative learning. *Educ Res, 38*, 365–379.

Joung, S. (2003). *The effects of high-structure cooperative versus low-structure collaborative design on online debate in terms of decision making, critical thinking, and interaction pattern.* Unpublished doctoral dissertation, The Florida State University.

Khan, B.H. (2001). *Web-based training*. Educational Technology Publications.

King, A. (2006). Scripting collaborative learning processes: A cognitive perspective. In: F. Fischer, I. Kollar, H. Mandl, & J. Haake (eds.), *Scripting computer-supported collaborative learning: Cognitive, computational and educational perspectives*. New York: Springer.

King, A. (2007). Scripting collaborative learning processes: A cognitive perspective. In A. O'Donnell and A. King (Eds.), *Scripting computer-supported collaborative learning: Cognitive perspectives on peer learning* (pp. 13–37). New York, NY: Springer US.

Kirschner, F., Paas, F., & Kirschner, P. A. (2009). Effects of individual and group-based learning from complex cognitive tasks on efficiency of retention and transfer performance. *Computers in Human Behavior, 25*, 306–314.

Kobbe, L., Weinberger, A., Dillenbourg, P., Harrer, A., Hämäläinen, R., Häkkinen, P., & Fisher, F. (2007). Specifying computer-supported collaboration scripts. *Comput. Support. Collaborative Learn. 2*, 211–224.

Kollar, I., Fischer, F. & Hesse, F.W. (2006). Collaboration Scripts – A Conceptual Analysis. *Educational Psychology Review, 18***,** 159–185. https://doi.org/10.1007/s10648-006-9007-2

Kollar, I., Fischer, F., & Slotta, J.D. (2005). Internal and external collaboration scripts in web-based science learning at schools. In: Koschmann, T., Suthers, D., & Chan, T.-W. (eds.), *Computer supported collaborative learning 2005: The next 10 Years.* Lawrence Erlbaum, Mahwah, NJ, pp. 331–340.

Kollar, I., Fischer, F., & Slotta, J. D. (2007). Internal and external collaboration scripts in web-based science learning at schools. *Learning and instruction, 17*(6), 708-721.

Kulik, J. A., & Kulik, C. L. (1979). College teaching. *Research on teaching: Concepts, findings, and implications*, 70-93.

Kyndt, E., Raes, E., Lismont, B., Timmers, F., Cascallar, E., & Dochy, F. (2013). A meta analysis of the effects of face-to-face cooperative learning. Do recent studies falsify or verify earlier findings?. *Educational Research Review, 10*, 133-149.

Laal, M., & Ghodsi, S. M. (2012). Benefits of collaborative learning. *Procedia-social and behavioral sciences, 31*, 486-490.

Lazakidou, G., & Retalis, S. (2010). Using computer supported collaborative learning strategies for helping students acquire self-regulated problem-solving skills in mathematics. *Computers & Education, 54*(1), 3–13.

Lazonder, A. W. (2005). Do two heads search better than one?: Effects of student collaboration on web search behaviour and search outcomes. *British Journal of Educational Technology, 36*(3), 465–475.

Le, H., Janssen, J., & Wubbels, T. (2018). Collaborative learning practices: teacher and student perceived obstacles to effective student collaboration. *Cambridge Journal of Education, 48*(1), 103-122.

Liu, S., Joy, M. & Griffiths, N. (2010). "Students' perceptions of the factors leading to unsuccessful group collaboration", *In: Advanced Learning Technologies (ICALT), 2010 IEEE 10th International Conference on*, IEEE, Sousse, Tunisia, 5-7 Jul, pp. 565-569.

Lou, Y., Abrami, P. C., Spence, J. C., Paulsen, C., Chambers, B., & d'Apollonio, S. (1996). Withinclass grouping: A meta-analysis. *Review of Educational Research, 66*(4), 423–458.

Macaro, E. (1997). *Target language, collaborative learning and autonomy* (Vol. 5). Multilingual Matters.

Manlove, S., Lazonder, A. W., & De Jong, T. (2009). Collaborative versus individual use of regulative software scaffolds during scientific inquiry learning. *Interactive Learning Environments, 17*(2), 105-117

Mercer, N. (2004). Sociocultural discourse analysis: Analyzing classroom talk as a social mode of thinking. *Journal of Applied Linguistics*, *1*(2), 137-168.

Mercer, N., Dawes, L., Wegerif, R., & Sams, C. (2004). Reasoning as a scientist: Ways of helping children to use language to learn science. *British Educational Research Journal, 30*(3), 359–377. doi: 10.1080/0141192041000168968 9.

Ning, H. (2013). "The Impact of Cooperative Learning on English as a Foreign Language Tertiary Learners' Social Skills." *Social Behavior and Personality, 41*, pp. 557–568.

O'Donnell, A., & Dansereau, D. F. (1992). Scripted cooperation in student dyads: A method for analyzing and enhancing academic learning and performance. In Hertz-Lazarowitz, R. & Miller, N. (Eds.), *Interaction in cooperative groups: The theoretical anatomy of group learning* (pp. 120–141). New York: Cambridge University Press.

Oflaz, M., & Turunc, T. (2012). The effect of learning styles on group work activities. *Procedia-Social and Behavioral Sciences, 46*, 1333-1338.

Papasalouros, A., & Chatzimichalis, G. (2020). An Authoring Platform for CSCL Script Definition. In P. Zaphiris & A. Ioannou (Eds.), *Learning and Collaboration Technologies. Human and Technology Ecosystems* (pp. 625–640). Cham: Springer International Publishing.

Persico, D., & Pozzi, F. (2011). Task, Team and Time to structure online collaboration in learning environments. *World Journal on Educational Technology, 3*(1), 1-15.

Puntambekar, S. (2006). Analyzing collaborative interactions: Divergence, shared understanding and construction of knowledge. *Computers & Education, 47*, 332–351.

Race, P. (2000). *500 tips on group learning*. New York: Routledge.

Ross, J. A. (2008). Explanation giving and receiving in cooperative learning groups. *In The teacher's role in implementing cooperative learning in the classroom*. Springer, Boston, MA.

Saab, N., Van Joolingen, W. R., & Van Hout-Wolters, B. H. A. M. (2007). Supporting communication in a collaborative discovery learning environment: The effect of instruction. *Instructional Science, 35*(1), 73-98.

Saleh, M., Lazonder, A. W., & Jong, T. D. (2007). Structuring collaboration in mixed-ability groups to promote verbal interaction, learning, and motivation of average-ability students. *Contemporary Educational Psychology, 32*(3), 314-331.

Scager, K., Boonstra, J., Peeters, T., Vulperhorst, J., & Wiegant, F. (2016). Collaborative learning in higher education: Evoking positive interdependence. *CBE—Life Sciences Education, 15*(4), ar69.

Schank, R.C., & Abelson, R.P. (1977). *Scripts, plans, goals and understanding*. Erlbaum, Hillsdale, NJ.

Schraw, G., Crippen, K. J., & Hartley, K. (2006). Promoting Self-Regulation in Science Education: Metacognition as Part of a Broader Perspective on Learning. *Research in Science Education, 36*(1-2), 111-139.

Srinivas, H. (2011). *What is Collaborative Learning?* The Global Development Research Centre, Kobe; Japan. Retrieved from: http://www.gdrc.org/kmgmt/c-learn/index.html.

Slavin, R. E. (2015). Cooperative learning in elementary schools. Education 3-13: *International Journal of Primary, Elementary and Early Years Education, 43*(1), 5-14

Smith, K. A. "Cooperative Learning: Effective Teamwork for Engineering Classrooms." *IEEE Education Society/ASEE Electrical Engineering Division Newsletter*, March 1995, pp. 1-6.

Smith, M. K., Wood, W. B., Adams, W. K., Wieman, C., Knight, J. K., Guild, N., & Su, T. T. (2009). Why peer discussion improves student performance on in-class concept questions. *Science*, *323*, 122–124. http://dx.doi.org/10.1126/science.1165919

Spiro, R.J., Feltovich, P.J., Jacobson, M.J., & Coulson, R.L. (1991). Cognitive flexibility, constructivism, and hypertext: Random access instruction for advanced knowledge acquisition in ill-structured domains. *Educational Technology, 31*(5), 24–33.

Stern, D., & Huber, G. L. (1997). *Active learning for students and teachers*. Reports from Eight Countries. Frankfurt am Main: Peter Lang.

Sung, H., & Hwang, G. (2013). A collaborative game-based learning approach to improving students' learning performance in science courses. *Computers & Education, 63*(2013), 43-51.

Tao, P. K., & Gunstone, R. F. (1999). Conceptual change in science through collaborative learning at the computer. *International Journal of Science Education*, *21*, 39 –57. http://dx.doi.org/10.1080/ 095006999290822

Tomcho, T. J., & Foels, R. (2012). Meta-analysis of group learning activities: Empirically based teaching recommendations. *Teaching of Psychology, 39*(3), 159-169.

Van Dijk, A., Eysink, T., Jong, T. de, (2019). Supporting Cooperative Dialogue in Heterogeneous Groups in Elementary Education. *Small Group Research*, pp.1-28. https://doi.org/10.1177/1046496419879978

Veenman, S., Kenter, B., & Post, K. (2000). Cooperative learning in Dutch primary classrooms. *Educational Studies, 26*(3), 281-302.

Vygotsky, L. (1978). Mind in society: *The development of higher psychological processes* (Ed. by M. Cole, V. John-Steiner, S. Scribner, & E. Souberman). Cambridge, MA: Harvard University Press.

Wang, Q. (2009). Design and evaluation of a collaborative learning environment. *Computers & Education, 53*(4), 1138-1146.

Webb, N. M. (1989). Peer interaction and learning in small groups. *International journal of Educational research, 13*(1), 21-39.

Webb, N. M. (2009). The teacher's role in promoting collaborative dialogue in the classroom. *British Journal of Educational Psychology, 79*, 1–28.

Weinberger, A., Ertl, B., Fischer, F., & Mandl, H. (2005). Epistemic and social scripts in computer-supported collaborative learning. *Instructional Science, 33*(1), 1–30.

Weinberger, A., Clark,D. B., Häkkinen,P., Tamura,Y., & Fischer, F. (2007). Argumentative knowledge construction in online learning environments in and across different cultures: A collaboration script perspective. *Research in Comparative and International Education, 2*, 68–79.

Wilson, J. M., Goodman, P. S., & Cronin, M. A. (2007). "Group learning". *Academy of Management, 32*(4), pp. 1041-1059.

Yasmin, M., & Naseem, F. (2019). Collaborative learning and learner autonomy: Beliefs, practices and prospects in Pakistani engineering universities. *IEEE Access*, *7*, 71493–71499. doi:10.1109/ACCESS.2019.2918756

Zambrano, J., Kirschner, F., Sweller, J., & Kirschner, P. A. (2019). Effects of prior knowledge on collaborative and individual learning. *Learning and Instruction, 63*, 101214. https://doi.org/10.1016/j.learninstruc.2019.05.011

Appendices

Appendix 1: Informed consent form

INFORMED CONSENT FORM

The effects of collaborative scripts and group cooperation in learning from the video
By Dilafruz Yusifzada

Purpose of The Study
This research is being conducted as part of my MSc thesis. I am inviting you to participate in this research project about studying the effects of collaborative scripts and group cooperation in learning from the video. The purpose of this research project is to compare individual and group learning with and without scripts to see which one or combination of multiple features is more effective for learning with video.

Procedures
You will participate in an experiment lasting approximately 1 hour. You will be asked to fill in some demographical questions (e.g. age, gender), you will receive a prior knowledge questionnaire right after that. Then you will be instructed to watch a video. After watching you will have to do a task (concept map) related to the video content. Afterwards you will continue filling in two questionnaires.

Potential Risks and Discomforts
There are no obvious physical, legal or economic risks associated with participating in this study. You do not have to answer any questions you do not wish to answer. Your participation is voluntary, and you are free to discontinue your participation at any time.

Potential Benefits
Participation in this study does guarantee some beneficial results to you. As a result of participating you may better understand the stages of cognitive development based on Piaget's theory.

Confidentiality
Your privacy will be protected to the maximum extent allowable by law. No personally identifiable information will be reported in any research product. Moreover, only trained research staff will have access to your responses, in this case only the researcher and supervisor.

Right to Withdraw and Questions
Your participation in this research is completely voluntary. You may choose not to take part at all. If you decide to participate in this research, you may stop participating at any time. If you decide not to participate in this study or if you stop participating at any time, you will not be penalized or lose any benefits to which you otherwise qualify.

If you decide to stop taking part in the study, if you have questions, concerns, or complaints, or if you need to report an injury related to the research, please contact the primary investigator: Dilafruz Yusifzada, d.yusifzada@student.utwente.nl, MSc Educational Science & Technology Student.

Statement of Consent
Your signature indicates that you have read this consent form; your questions have been answered to your satisfaction and you voluntarily agree that you will participate in this research study.

I agree to participate in a research project led by Dilafruz Yusifzada. The purpose of this document is to specify the terms of my participation in the project.

1. I have been given sufficient information about this research project. The purpose of my participation as a participant in this project has been explained to me and is clear.

2. My participation in this project is voluntary. There is no explicit or implicit coercion whatsoever to participate.

3. Participation involves filling in questionnaires and watching a video. The experiment will last approximately 60 minutes. I allow the researcher to use my data gathered for her study. It is clear to me that in case I do not want to continue I am at any point of time fully entitled to withdraw from participation.

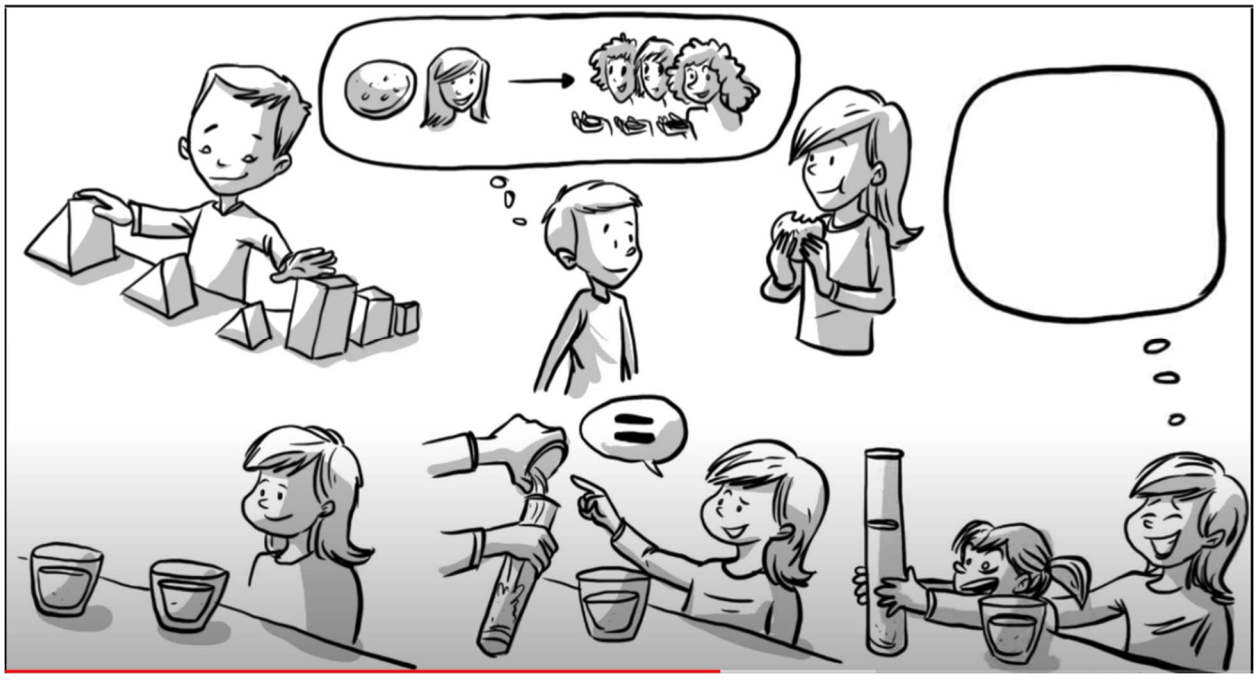
4. I have been given the guarantee that this research project has been reviewed and approved by the BMS Ethics Committee. For research problems or any other question regarding the research project, the Secretary of the Ethics Commission of the faculty Behavioural, Management and Social Sciences at University Twente may be contacted through ethicscommittee-bms@utwente.nl

5. I have read and understood the points and statements of this form. I have had all my questions answered to my satisfaction, and I voluntarily agree to participate in this study.

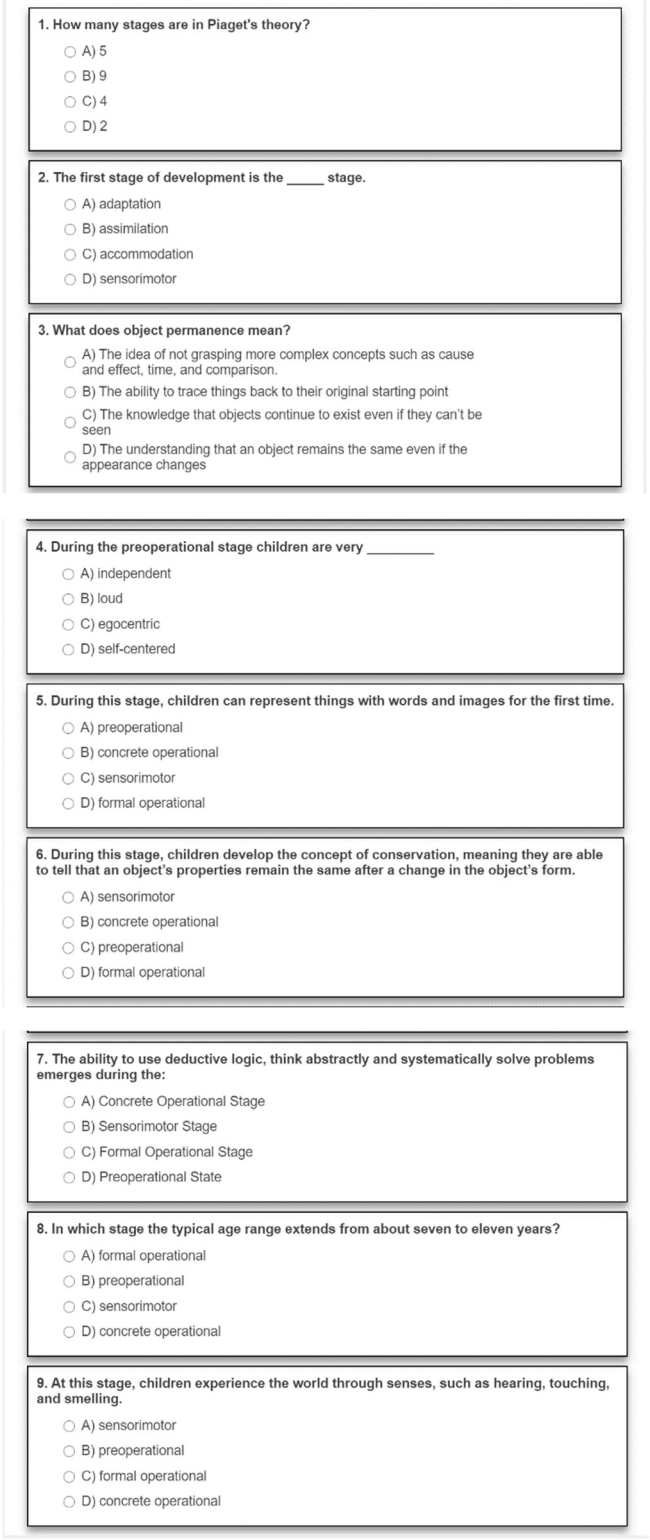
Dilafruz Yusifzada

Full name of the researcher - As seen as signature

Appendix 2: Example screenshots from the video



Appendix 3: Pre-knowledge test



1. How many stages are in Piaget's theory?
   - A) 5
   - B) 9
   - C) 4
   - D) 2

2. The first stage of development is the _____ stage.
   - A) adaptation
   - B) assimilation
   - C) accommodation
   - D) sensorimotor

3. What does object permanence mean?
   - A) The idea of not grasping more complex concepts such as cause and effect, time, and comparison.
   - B) The ability to trace things back to their original starting point
   - C) The knowledge that objects continue to exist even if they can't be seen
   - D) The understanding that an object remains the same even if the appearance changes

4. During the preoperational stage children are very _____
   - A) independent
   - B) loud
   - C) egocentric
   - D) self-centered

5. During this stage, children can represent things with words and images for the first time.
   - A) preoperational
   - B) concrete operational
   - C) sensorimotor
   - D) formal operational

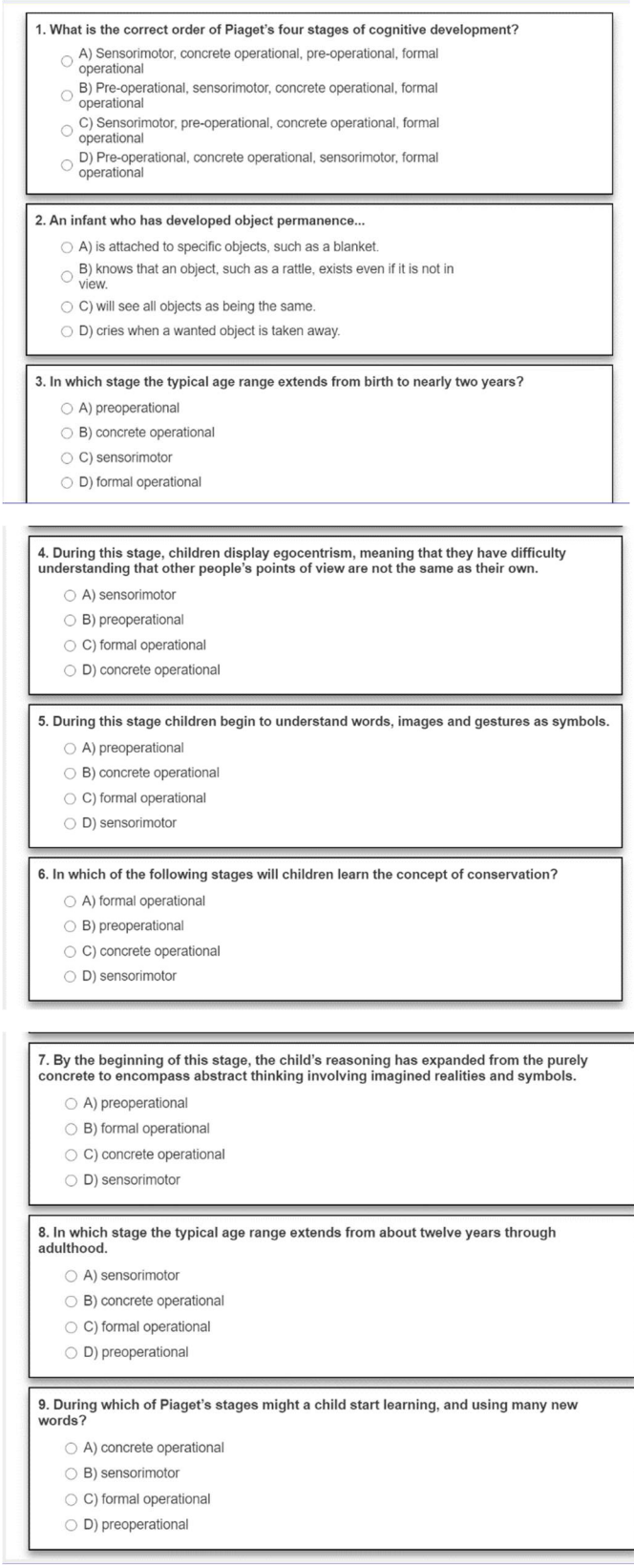
6. During this stage, children develop the concept of conservation, meaning they are able to tell that an object's properties remain the same after a change in the object's form.
   - A) sensorimotor
   - B) concrete operational
   - C) preoperational
   - D) formal operational

7. The ability to use deductive logic, think abstractly and systematically solve problems emerges during the:
   - A) Concrete Operational Stage
   - B) Sensorimotor Stage
   - C) Formal Operational Stage
   - D) Preoperational State

8. In which stage the typical age range extends from about seven to eleven years?
   - A) formal operational
   - B) preoperational
   - C) sensorimotor
   - D) concrete operational

9. At this stage, children experience the world through senses, such as hearing, touching, and smelling.
   - A) sensorimotor
   - B) preoperational
   - C) formal operational
   - D) concrete operational

Appendix 4: Post-knowledge test



1. What is the correct order of Piaget's four stages of cognitive development?

- A) Sensorimotor, concrete operational, pre-operational, formal operational
- B) Pre-operational, sensorimotor, concrete operational, formal operational
- C) Sensorimotor, pre-operational, concrete operational, formal operational
- D) Pre-operational, concrete operational, sensorimotor, formal operational

2. An infant who has developed object permanence...

- A) is attached to specific objects, such as a blanket.
- B) knows that an object, such as a rattle, exists even if it is not in view.
- C) will see all objects as being the same.
- D) cries when a wanted object is taken away.

3. In which stage the typical age range extends from birth to nearly two years?

- A) preoperational
- B) concrete operational
- C) sensorimotor
- D) formal operational

4. During this stage, children display egocentrism, meaning that they have difficulty understanding that other people's points of view are not the same as their own.

- A) sensorimotor
- B) preoperational
- C) formal operational
- D) concrete operational

5. During this stage children begin to understand words, images and gestures as symbols.

- A) preoperational
- B) concrete operational
- C) formal operational
- D) sensorimotor

6. In which of the following stages will children learn the concept of conservation?

- A) formal operational
- B) preoperational
- C) concrete operational
- D) sensorimotor

7. By the beginning of this stage, the child's reasoning has expanded from the purely concrete to encompass abstract thinking involving imagined realities and symbols.

- A) preoperational
- B) formal operational
- C) concrete operational
- D) sensorimotor

8. In which stage the typical age range extends from about twelve years through adulthood.

- A) sensorimotor
- B) concrete operational
- C) formal operational
- D) preoperational

9. During which of Piaget's stages might a child start learning, and using many new words?

- A) concrete operational
- B) sensorimotor
- C) formal operational
- D) preoperational

Appendix 5: Collaboration experience questionnaire

Please review the questions below and select a response you find the most accurate to your current situation.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Interacting with peers for this group assignment enriched my knowledge and understanding of Piaget's theory of Cognitive Development	○	○	○	○	○
Working in a group provided me with the opportunity to get feedback on my understanding	○	○	○	○	○
This group assignment gave me a chance to learn from my peers' contribution	○	○	○	○	○
This group assignment gave me a valuable opportunity to rethink my own ideas	○	○	○	○	○
Participating in this group assignment gave me a chance to consider different opinions and thus broaden my understanding	○	○	○	○	○

Appendix 6: An example scripted instruction

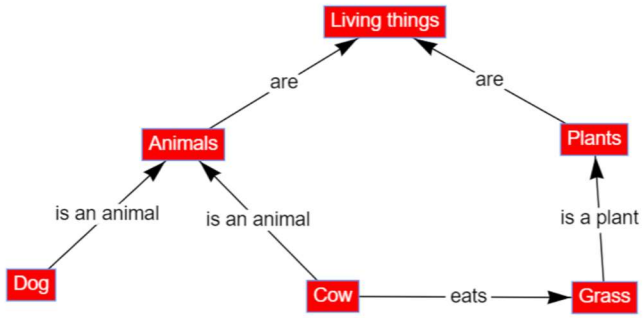
Before we start with video-watching, please answer the questions below about Piaget's Theory of Cognitive Development.

Now you are ready to create the concept map. Each of the group members has watched the video about one stage of the cognitive development, but you need to create a concept map together about 4 stages.

You can use the **Chat window** on the right to talk and discuss with your group members.

Appendix 7: Instructions for the concept mapping tool

Before you start, please look at the example concept map about "Living things" given below to see what concept map is and how the connections between concepts are made.



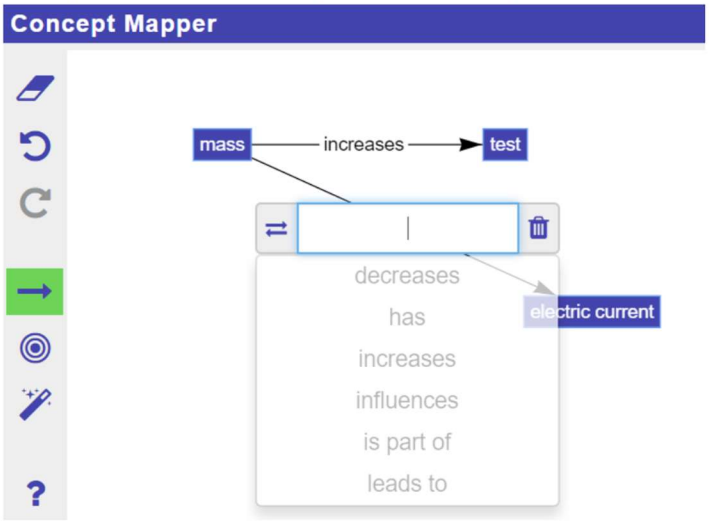
The description of the icons below will help you understand how to create a concept map and when/why to use these symbols.

The color of a text box can be changed by clicking on the brush icon

A term can be deleted by clicking on it and then clicking on the trash bin

To change the position of a term, simply click and drag.

When the arrow is clicked the relations between concepts mode is activated and the button is highlighted in green. To draw a relation line, click and drag from one concept to another and name the relation, either by typing a new word/phrase or by selecting a predefined relation. Naming the relation is obligatory.



Relations between concepts

The other buttons perform the following actions:

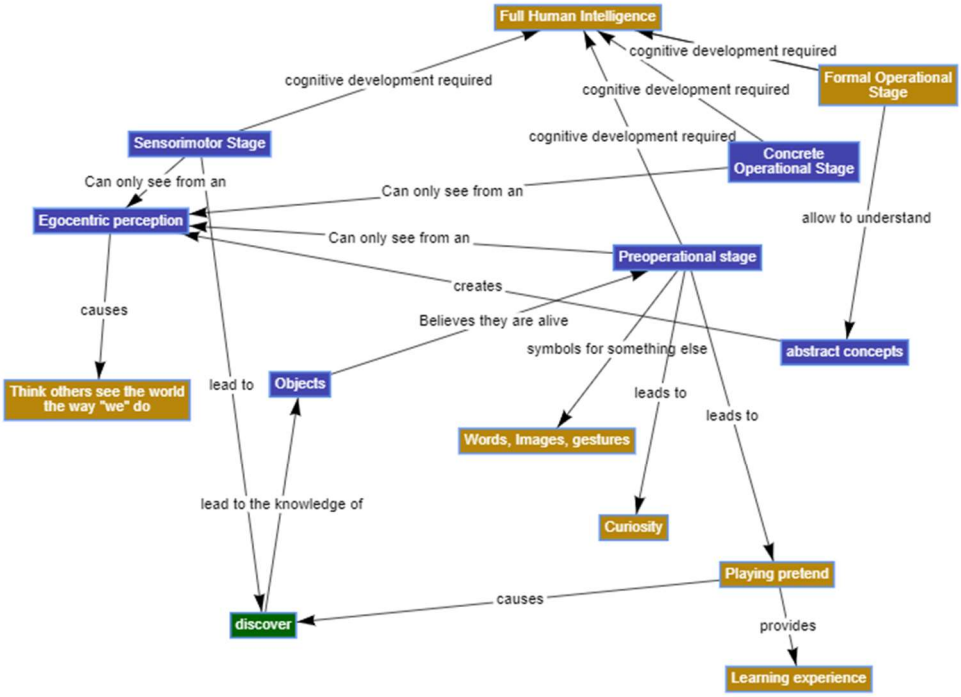
Delete all content of concept map.

Undo or Redo changes made.

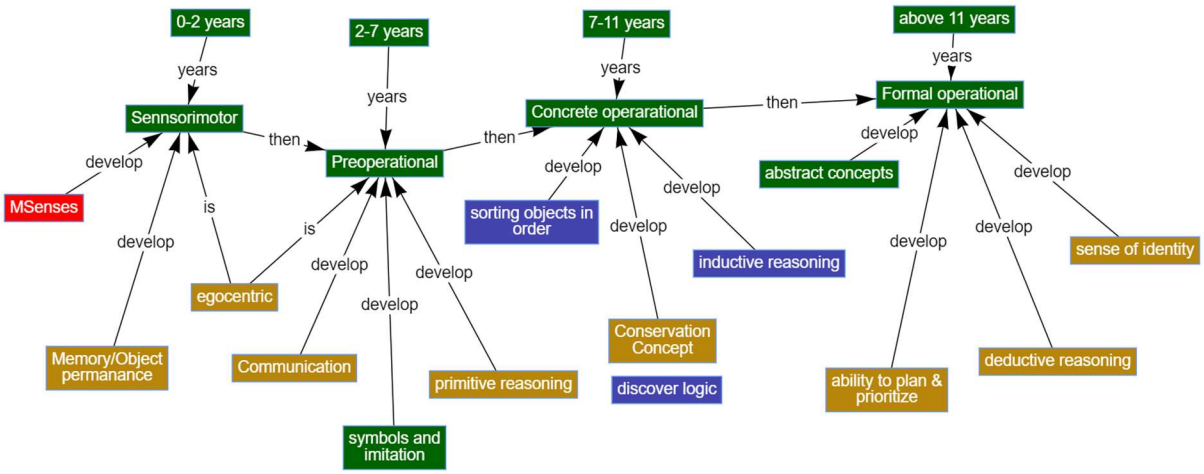
Center concept map on the screen.

Change the layout of the concept map to a more compact form.

Appendix 8: An example concept map from structured condition



Appendix 9: An example concept map from unstructured condition



Appendix 10: The codebook

The codebook to check the concept maps

- If the statement is explicitly written/explained on the concept map, it gets **1 full point.**
- If some part of the statement is implicitly mentioned, it gets **0.5 points.**
- If there is no information about certain statement, the concept map gets **0 point** for that statement.

Category	**Statement**	**Score**		
		0	**0.5**	**1**
General – 4 stages of Cognitive Development	There are 4 stages of Cognitive development.			
	The names of the stages are correctly written.			
	The order of the stages is correct.			
	When we go through all stages, we can reach full human intelligence.			
Sensorimotor stage	Age 0-2			
	Develop through experiences and movement			
	5 senses – see, hear, smell, taste, touch			
	Simple reflexes			
	First habits			
	4 months < Being aware of things beyond our body			
	Learn to do things intentionally			

	Development of working memory			
	Realization of object permanence			
	Teddy experiment			
	Becoming curious about everything			
	Increased physical mobility – sitting, crawling, standing, walking, running			
	Increased cognitive development			
	Being ego-centric			
	Perceiving the world only from our point of view			
Preoperational stage	Age 2-7			
	Categorized thinking through symbolic functions			
	Intuitive thoughts / fantasies			
	Not being able to apply specific cognitive operations			
	Learn to speak			
	Understand words, images, gestures as symbols for something else			
	Drawing (symbolic) experiment			
	To play pretend – experience & learn a lot			

	Becoming more curious / asking questions			
	Birth of primitive reasoning			
	Intuitive age			
	Ego-centric thinking			
Concrete operational stage	Age 7-11			
	Discover logic			
	Develop concrete cognitive operations			
	Sorting object in a certain order			
	Inductive reasoning			
	Making generalization			
	Concept of conservation			
	Orange juice experiment			
	3+5=8 experiment			
	Rearranging thoughts			
	Concrete operational mental structures			
	Reversing an action			
	Learn to write			

	Understanding uniqueness of our thoughts			
Formal operational stage	Age 12 +			
	Becoming formally operational			
	Rational thinking			
	Understand abstract concepts			
	Understanding hypothetical events			
	Advanced cognitive abilities			
	Deeper understanding of our own identity and morality			
	Deductive reasoning			
	Comparing / reaching logical generalization			
	Systematical planning & prioritizing			
	Making assumptions about events not related to reality			
	Being able to philosophize (Thinking about thinking)			
	Ego-centric thoughts			
	Imaginary audience watching us			