Master Thesis

The Relationship Between Self-Regulated Learning (SRL) and Socially Shared Regulation of Learning (SSRL) during Collaborative Learning

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Table of Content

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Enjoy reading my master thesis!

Summary

A topic that reappeared in educational psychology is regulation of learning. In self-regulated learning (SRL), students take an active role in their learning process. Research on this has commonly focused on individual students. One of the concepts where research is broadened is socially shared regulating of learning (SSRL). When students collectively steer their work in a group by using cognitive and metacognitive strategies, and they adapt their behaviour and motivation, then they engage in socially shared regulation of learning.

This study first tested to what extent students' individual levels of SRL are related to their contribution to SSRL during collaborative learning. Secondly, this study tested to what extent Dutch primary school students' individual differences in prior knowledge influence their contribution to SSRL. Thirdly, this study tested to what extent an external micro-and macro-level collaboration script with epistemic and social aspects for guiding collaborative learning does influence SSRL of the individual members of the group. An experimental condition (N = 19), aided with a collaboration script, was compared to a control condition (N = 16) that did not have access to the script. The research design was a cross-sectional experimental design. 37 grade six students from a Dutch primary school participated using convenience sampling. A questionnaire, which measured the level of SRL, and a domain knowledge test to determine the prior knowledge were administered to divide the students into heterogeneous collaboration groups of four or five. The collaboration groups fulfilled a collaborative learning assignment that was video recorded. The video recordings were coded with ELAN software by using a previously developed model.

Firstly, from the results, it appeared that students engaged more in co-regulation than in SSRL. Moreover, the results showed no significant correlation between students' individual SRL and their contribution to SSRL and also no correlation between prior knowledge and SSRL. For the second point, there were also no statistical differences between the different levels of the domain knowledge test on SSRL. Furthermore, it was shown that there was no difference between the experimental and control condition on SSRL. Future research should look at how the subcategories motivation and behaviour, which are primarily co-regulated, contribute to the model of SSRL. Moreover, future research is needed to investigate if other individual differences affect how students collaborate in a group, and in this way their contribution to SSRL.

Keywords: Self-Regulated Learning, Socially Shared Regulation of Learning, Collaborative Learning, Prior Knowledge, Collaboration Script

1. Introduction

In the past decades, a reoccurring topic in educational psychology is the use of strategies in which students regulate their own learning (Panadero & Järvelä, 2015). Attention to this topic is increasing because there is a consensus that successful learners adopt a variety of cognitive, behavioural and motivational strategies to steer and improve their learning processes whilst also completing academic tasks (Panadero & Järvelä, 2015). Studies about the use of regulating learning started to occur when Flavell introduced the metacognition theory in 1979. After this, self-regulation theories started to flourish.

Students who for example, set goals, plan, monitor and evaluate before, during and after a learning task are self-regulating their learning (Zimmerman, 2002). In literature about self-regulated learning, the process of SRL is mostly seen as a process for individual learning situations. However, according to Järvelä and Hadwin (2013), in group processes the level of SRL that an individual student has also plays a role. In a group, individual learners still need to activate their personal strategies, and they have their personal goals, which might or might not be aligned with the goals of the group (Järvelä & Hadwin, 2013; Panadero et al., 2015).

Recently one of the concepts where research is broadened is socially shared regulation of learning (SSRL). In a group, individual students collectively steer their work to achieve shared goals. This can be done by using cognitive and metacognitive strategies (e.g., making a planning together), and adapting their behaviour (e.g., commenting on group members' behaviour) and motivation. This is called socially shared regulation of learning (SSRL) (Hogenkamp et al., 2021; Panadero & Järvelä, 2015; Rogat & Linnenbrink-Garcia, 2011). The difference between SRL skills in a group process and the use of SSRL is that in SSRL students collectively share the process while SRL focuses on the individual learning situation (Panadero & Järvelä, 2015). According to Hadwin et al. (2017) for SSRL, it is important that all group members contribute.

SSRL is necessary for effective collaborative learning (Van Den Bossche et al., 2006). In collaborative learning, students construct a shared understanding through interaction with others. They are engaged in shared goals and problem solving (Järvelä et al., 2015). Ideally, if students use SSRL in collaborative learning, this will help them to improve decision-making and adaptation of collaborative processes, which complement learning (Hadwin et al., 2017; Hogenkamp et al., 2021). Nonetheless, research has shown that students often have a hard time regulating their collective learning process (Hogenkamp et al., 2021; Järvelä et al., 2015). It is important to support the process of collaborative learning because problems can arise on the cognitive, motivational and socio-emotional levels (Van Den Bossche et al., 2006). Participating in SSRL needs additional communication and coordination. This can be difficult because every student is already an individual self-regulator with learning goals, approaches, and emotions (Zimmerman, 2002).

So, in collaborative learning settings, students need to regulate their own learning but also play a role in regulating the learning of the group (Panadero et al., 2015). Few things are known about the relationship between students' individual SRL and SSRL during collaborative learning. The difference between SRL and SSRL is that SRL refers to individual learners whilst SSRL refers to the group. In both SRL and SSRL learners take metacognitive control of cognitive, behavioural, motivational and emotional aspects, but in SRL students do this form their self and in SSRL the group does this together (Hadwin et al., 2017). It is expected that there is a relationship between individual SRL and SSRL because better self-regulated learners will show a broader range of learning strategies that can be applied in a group setting (Panadero et al., 2015). However, according to previous research, several things are known. Hadwin et al. (2017) posit that SRL is necessary for optimal collaboration in a group. Another posit is that not only SRL but SSRL also plays a critical role in optimal collaborative learning (Järvelä et al., 2016). Moreover, Hadwin et al. (2017) mention that every regulation is based on students' personal developed knowledge, beliefs, and models that they bring to new learning situations. Students thereby influence the approach that they use and the decision-making process. It is important to investigate the possible relationship between SRL and SSRL in collaborative learning so that schools can focus on improving students' SRL and in this way their contribution to SSRL.

The possible relationship could be that SSRL is influenced by SRL due to individual characteristics that students bring to the group (Panadero & Järvelä, 2015). For example, according to Panadero and Järvelä (2015), emotional security, interdependence, and self-assurance can play a role in the activation of SSRL in a group. Panadero and Järvelä (2015) state that it is possible to clarify how SSRL can be encouraged by looking at what happened during the collaboration, as well as what the students bring to the collaboration. Furthermore, Panadero and Järvelä (2015) state that group dynamics should be considered. A student who feels that another group member is seen as an expert on the topic might consider following the expert. In this way, SSRL possibly does not take place because one person (the expert) is guiding the group instead of groups who collectively regulate.

This research aims to test if students' individual levels of SRL relates to their contribution to SSRL during collaborative learning. Moreover, this research will show if individual differences and a collaborative learning scaffold influence SSRL. The knowledge from this research can be used to support the process and occurrence of SSRL during collaborative learning, in this way students can work better together in groups which leads to advanced learning outcomes.

2. Theoretical Framework

2.1 Self-Regulated Learning (SRL)

Various terms are used for a self-directed process in which students use strategies to build and regulate their knowledge: self-regulated learning, self-regulation, metacognition and self-directed learning (Boekaerts & Corno, 2005; Dawson & Guare, 2010; Zimmerman, 2000; 2002). In this study, the definition of Zimmerman (2002) is used since this is one of the first SRL authors and has been used in several literature reviews and meta-analyses about SRL (Panadero, 2017; Panadero et al., 2017; Zumbrunn et al., 2011). Zimmerman (2002) describes the process as self-regulated learning (SRL), which is the extent to which learners actively participate in their own learning process. Furthermore, Zimmerman (2002) describes SRL as an activity that learners do for themselves, it is seen as an active process in response to the lesson offered. The learners are active in their intention to learn because they are aware of their strengths and weaknesses and the learners are guided by their set goals and task-related strategies.

SRL is mostly divided into three phases: before, during and after each learning task (Zimmerman, 2002). Zimmerman (2002) described these phases as the forethought, performance and self-reflection phases. The forethought phase refers to the processes and thoughts that arise before learning starts (Zimmerman, 2002). The performance phase refers to the process that occurs while executing the task. The learners use strategies and methods to do so. In the last phase, the self-reflection phase, students reflect on a standard, such as a prior performance or an absolute standard and look at what causes the success or failure of the task process (Zimmerman, 2002).

In SRL, learning strategies that relate to metacognition and motivation of students are especially important (Zimmerman, 2002). Dawson and Guare (2010) define metacognition as the ability to take a step back to oversee yourself and the situation to see how to tackle a problem. It involves self-monitoring and self-evaluation. Secondly, motivation is important, according to Deci and Ryan (2000), there are different forms of motivation. Intrinsic motivation is perceived as the motivation that comes from within the individual. If the individual is intrinsically driven, the regulation of behaviour and the initiative to do something lies within the individual themself. The individual undertakes something because they want to, because it gives them satisfaction or because they see that it contributes to the achievement of the goal (Deci & Ryan, 2000). The second form is extrinsic motivation, which is caused by a certain pressure or command from the outside world. In this form of motivation, a task or activity is carried out to achieve a certain outcome. Often, this is to receive a reward or to avoid a punishment (Deci & Ryan, 2000). Motivation is important for SRL because if students have a good motivation they carry on to improve their methods of learning (Zimmerman, 2002).

Next to metacognition and motivation, behaviour and regulation of emotions play a role. Behaviour is what students do to guide their actions (Sins et al., 2019). By adjusting the behaviour and being able to steer it, students can actively participate in their learning process (Sins et al., 2019; Zimmerman, 2002). Additionally, McClelland et al. (2010) see the regulation of emotions as an aspect that can influence SRL. Being able to deal with emotions is a precondition for steering behaviour, motivation and cognition (Blair & Razza, 2007). When a student is not capable of regulating their emotion, the student can become preoccupied with these emotions and is less capable of gaining information correctly (Van Tuijl & Deterd Oude Weme, 2012).

In sum, a process in which students actively work on their own development in the areas of metacognition, motivation and behaviour, taking into account the emotion that can precede and arise during this process, is called self-regulated learning (SRL). Students do this by setting goals and using learning strategies (McClelland et al., 2010; Zimmerman, 2002).

2.2 Socially Shared Regulation of Learning (SSRL)

Next to individual learning and the regulation of this process, students can also collaborate with others in a dyad or group. In this case, they do not only need to regulate their own process but also play a role in regulating the learning of the group (Panadero et al., 2015). Different terms are used for social forms of regulation, such as co-regulation, other-regulation, shared metacognition and socially shared regulation of learning (Hadwin et al., 2017; Järvelä et al., 2013; Panadero & Järvelä, 2015). Therefore, defining and operationalizing the social aspect of SSRL is an ongoing discussion. Different levels and aspects of regulation of learning in collaborative situations can be shown, the terms co-regulation and SSRL are often used in this (Panadero & Järvelä, 2015). The main distinction is that co-regulation is seen as a process in which group members regulate each other's learning, while SSRL is seen as a process in which individual group members share their regulatory process (Hogenkamp et al., 2021; Panadero & Järvelä, 2015). For example, co-regulation happens when one student is making a planning for the whole group, and SSRL happens when the group members make the planning together to achieve the shared goal. There still seems to be some confusion concerning these terms because Panadero and Järvelä (2015) found that some studies use the term co-regulation while SSRL is described.

While the skills for SRL are mostly focused on regulating the learning process related to the task, for SSRL, the regulation of social aspects in a group is also needed (Hogenkamp et al., 2021). Social interactions, such as encouraging involvement, can make sure that the participation of group members increases. As mentioned above, SSRL involves the regulation of a shared activity, Volet et al. (2009) state that when groups participate in SSRL, the task is recognized as less difficult. Better learning outcomes are achieved for groups who participate in SSRL in comparison to groups who do

not engage in SSRL. However, Järvelä et al. (2016) mention that group members are often unaware of their fellow group members' goals and strategies. Therefore, it is stated that it is helpful, to know the differences between students, in terms of goals and strategies, to adjust the support to their needs.

In sum, SSRL is when individual students regulate their collective activity in a group by using joint cognitive and metacognitive regulatory strategies and adapting behaviour and motivation (Panadero & Järvelä, 2015; Rogat & Linnenbrink-Garcia, 2011).

2.3 Collaborative Learning and Collaboration Scripts

Socially shared regulation of learning (SSRL) is assumed to be a necessary skill for effective collaborative learning (Hadwin et al., 2017). In collaborative learning, students are brought together to collaborate on a task at the same time in order to learn from the task work and the group work. In this process, the interaction between group members and their reaction to interaction are the process by which mutual understanding and shared comprehension is achieved (Van Den Bossche et al., 2006).

However, the effectiveness of collaborative learning is not always reached (Van Den Bossche et al., 2006). According to Van Den Bossche et al. (2006), problems can appear on the cognitive, motivational and socio-emotional levels. On the cognitive level, problems can occur when students struggle to comprehend other group members' reasoning. On the motivational level, problems can arise when the group members do not have the same shared goal for the task (Järvenoja et al., 2013). Problems on the socioemotional level can occur when groups have a flawed interaction or communication (Järvenoja et al., 2013). When groups engage in SSRL, group members collectively regulate their group process. In this way, the described problems can be solved. However, as mentioned before, research has shown that students often have a hard time regulating their collective learning process because participating in SSRL needs additional communication and coordination (Hogenkamp et al., 2021; Järvelä et al., 2015).

If students are not able to complete a task on their own, as an individual or in groups, scaffolding is seen as a way that can support learners (Kollar et al., 2006). One of the scaffolds that can be used in collaborative learning is a collaboration script. It is a set of instructions designed to guide and assist learners in interactions and behaviour during collaborative learning so that all group members can benefit from the collaboration (King, 2007; Mäkitalo-Siegl & Kollar, 2012). The main idea behind the use of collaboration scripts is to implement a structured interaction by providing detailed instructions on how to interact, and in this manner improving the collaborative problem solving and acquisition of knowledge (Rummel & Spada, 2005). Mäkitalo-Siegl and Kollar (2012) add that a "collaboration script is characterized by its focus on supporting learning through direct manipulation of collaborative processes rather than through offering content-specific support" (p. 628). Collaboration scripts can be effective measures in face-to-face collaboration and online collaboration (Rummel &

Spada, 2005). A collaboration script could potentially contribute to the occurrence of SSRL in groups because a script supports social and cognitive processes by influencing how learners engage with one another (Kobbe et al., 2007).

Scripts can vary in their structure. Fischer et al. (2013) distinguish between internal collaboration scripts and external collaboration scripts. An internal collaboration script refers to the configuration of knowledge components that an individual has regarding collaborative aspects (Fischer et al., 2013). These kinds of knowledge components guide the individuals' understanding of and actions in the collaboration. For example, students are aware of specific communication skills, this is a component of the internal collaboration script (Kollar et al., 2006). These internal collaboration scripts are acquired through repeated experience in collaborative situations.

On the other hand, to compensate for the lack of knowledge, external collaboration scripts can be provided. An external collaboration script is "a configuration of representations of a collaborative practice and its parts at different levels of complexity, it is presented to a group of learners by an external source as a means to guide their collaborative activities" (Fischer et al., 2013, p. 57). An external script uses textual or graphical representations. For example, instructions written on a piece of paper could explicitly mention how the group members must act in order to achieve the goal of the collaboration (Kollar et al., 2006). So, by lack of an internal collaboration script, the configuration of knowledge components that a student has regarding collaborative aspects, an external collaboration script can guide the learners.

Moreover, there is a distinction between macro-scripts and micro-scripts. Macro-scripts support the structure of the process to improve interactions, while micro-script are more detailed and coordinate the collaboration (King, 2007; Mäkitalo-Siegl & Kollar, 2012). With a micro script, the exchange of unshared information is tried to be fostered (Rummel & Spada, 2005). A macro-level script can be formed by designing three phases to structure the process. Rummel and Spada (2005) describe in their article an exemplary collaboration, where the initial phase, main phase and final phase are shown. This exemplary collaboration includes aspects from the micro and macro level. In the initial phase, group members coordinate their collaboration and define the goals of the upcoming task. The group members also read the task description and plan the upcoming task (Rummel & Spada, 2005). In the main phase, the group members work on the task and exchange and discuss this information with each other (Rummel & Spada, 2005). At last, in the final phase, consistency and joint agreement on the end product of the task are the goals. The group members revise and discuss the outcomes before final changes to the task are made (Rummel & Spada, 2005).

Furthermore, Weinberger et al. (2005) also make a distinction between epistemic and social scripts. While collaboratively discussing and constructing knowledge, epistemic scripts can direct learners' attention to a specific aspect of the task and specific task-oriented activities (Weinberger et al., 2005). On the other hand, social scripts define and sequence learner interaction, such as eliciting information from one another through critical questioning (Weinberger et al., 2005).

In sum, problems can arise during collaborative learning. These problems can be solved when groups engage in SSRL. However, it is necessary to support the process of SSRL because SSRL needs additional communication and coordination and this does not happen by itself (Hogenkamp et al., 2021; Järvelä et al., 2015). A collaboration script, which can guide and aid learners in their collaborative learning process might contribute to the occurrence of SSRL in groups.

2.4 Individual Differences that can Influence SSRL during Collaborative Learning

SSRL could potentially be influenced by individual characteristics that students bring to the group. These individual characteristics are related to SSRL because when looking at the characteristics of the different group members, it can be essential to better understand how and when SSRL occurs (Panadero & Järvelä, 2015). Hogenkamp et al. (2021) investigated how SSRL is manifested during cooperative learning. One of the limitations was that their study observed large differences in the frequency of occurrence of SSRL between the groups, which was undetermined why. However, during observation, it was found that some students presented SSRL strategies but gained no response from their group members. Therefore, it is useful to find out if individual differences play a role in the occurrence of SSRL and which of them are involved. This is in line with the research of Panadero and Järvelä (2015), which stated that it is important to not only look at the groups' process but also at the individual differences that students take to a group.

Winne et al. (2010) state that little attention and sometimes no attention is paid to three resources every collaborator brings to the group: (1) prior knowledge, (2) task-related information that is not yet transformed into knowledge and (3) cognitive processes used to construct information. Firstly, prior knowledge is often the most potent variable in affecting learning outcomes. Winne et al. (2010) mention that the knowledge of a group is mostly bigger than the knowledge of an individual. An individual with lesser knowledge about a topic of the collaborative task benefits from the prior knowledge of other group members. Secondly, information that an individual can access but is not yet known by other group members, can be a resource in the collaboration. Thirdly, to transform information into knowledge, learners have their own tactics and strategies which they apply. It is assumed that these strategies of the individual learner are also applied in the collaborative setting (Winne et al., 2010).

Additionally, the social skills and personality characteristics of group members should be taken into account (Fransen et al., 2011). Socials skills are, for example, social perceptions, coordination, negotiation and instructing (Morgeson et al., 2005). Socials skills are important in group settings because working in groups increases the interdependence among group members. This requires more demands than when working individually (Morgeson et al., 2005).

In sum, individual differences such as prior knowledge should be taken into account when investigating the occurrence of SSRL during collaborative learning.

2.5 Research Questions and Hypotheses

The current study aims to test if students' individual SRL relates to SSRL and to what extent individual differences in prior knowledge and a collaboration script for guiding collaborative learning influence SSRL. The research questions of the current study are:

I. To what extent are students' individual levels of self-regulated learning (SRL) related to their contribution to socially shared regulation of learning (SSRL) during collaborative learning, for Dutch primary school students (grade six)?

II. To what extent do Dutch primary school students (grade six) individual differences in prior knowledge influence their contribution to SSRL?

III. To what extent does an external micro-and macro-level collaboration script with epistemic and social aspects for guiding collaborative learning influence SSRL of Dutch primary school students (grade six)?

In order to answer the research questions, a cross-sectional experimental design is used with an experimental and control condition, in which the experimental condition is aided with a combination of an external micro-and macro-level script with epistemic and social aspects. Collaboration group dialogues are coded to answer the research questions.

For the first research question, it is expected that students' individual SRL relates positively to their contribution to SSRL during collaborative learning, as an individual with high SRL will also regulate during collaborative learning. This hypothesis is also based on the research of Panadero et al. (2015), who explored the relationship between individual SRL and SSRL. These results revealed a significant relationship between these two. If the current study shows that there is a positive relationship between students' SRL and their contribution to SSRL, schools can focus on improving students' SRL, and in this way their contribution to SSRL. As mentioned before, there is a difference between co-regulation and SSRL. For effective collaborative learning, SSRL is necessary because all group members should contribute in the group. Therefore, this study focuses on SSRL because in SSRL all the individuals in the group are involved and collectively regulate their learning, whilst in co-regulation one group member is regulating other group members' learning.

Winne et al. (2010) state that sometimes no attention is paid to the prior knowledge that students bring to a group. The second hypothesis is that there is a relationship between individual differences in prior knowledge and students' contribution to SSRL. If the current study shows that there is a relationship between prior knowledge and students' contribution to SSRL, schools can focus on stimulating the prior knowledge of a task, and minimizing the differences between students, before they work in groups and in this way engage in SSRL.

The third research question will be measured on the level of the individual as well as for the group. The scores of students' level of SSRL in the experimental condition will be compared with the students' scores of SSRL in the control condition. The hypothesis is that there will be a difference between the experimental condition in SSRL that was aided with a collaboration script and the control condition who do not have access to the script, the use of a collaboration script is expected to have a positive influence on students' contribution to SSRL. Research has shown that students are often having a hard time regulating their collective learning process (Hogenkamp et al., 2021; Järvelä et al., 2015). A collaboration script can aid learners in regulating this process in a group. This study can help practically by testing a particular collaborative learning scaffold. If this collaboration script shows positive results for students' contribution to SSRL, schools can implement collaboration scripts in their teaching.

3. Research Method

3.1 Research Design

To examine if students' individual SRL relates to their contribution to SSRL, a cross-sectional experimental design was used in this study, with the level of SRL as the independent variable and the level of SSRL as the dependent variable. The individual differences in prior knowledge and the collaboration script were also independent variables. This research was cross-sectional because all data was collected at one point in time. It has to be taken into account that the time order of effects is not measured (Check & Schutt, 2017). Convenience sampling was used to gain participants. For the collaborative assignment, the students were categorised into one of three levels (insufficient, sufficient, and above sufficient) based on the scores of a questionnaire about SRL and a domain knowledge test. Subsequently, students were randomly assigned into collaboration groups. Students in the experimental condition were aided by a script in the assignment, which aimed to stimulate the process of SSRL. The control condition did not have access to the script. Two grade six classes participated, half of each class functioned as the control condition and the other half functioned as the experimental condition, this happened randomly and therefore it was an experimental design. This situation was chosen because in this way the results are not influenced based on the teaching of the teacher. Furthermore, in this way, both classes could gain experience from this research and students could experience the effect of working in collaboration groups that were based on prior knowledge and students' SRL. For the generalisation of this research, it has to be taken into account that convenience sampling does not necessarily reflect the population (Babbie, 2013).

3.2 Participants

The research sample consisted of 37 primary school students in grade six (11-12 years) from one primary school based in Deventer in the Netherlands (19 girls, 18 boys; M_{age} = 11.43, *SD* = .50). 44 students and their parents were asked for active consent after they were informed about the purpose of this study. In the end, 37 students participated in this study.

Students were assigned to heterogeneous collaboration groups of four or five based on their SRL questionnaire and their domain knowledge test. Students were scored on one of three levels (insufficient, sufficient, and above sufficient) for a SRL questionnaire and a domain knowledge test. Both scores were combined and if students' levels were the same on the questionnaire and the domain knowledge test, the overall score stayed the same (e.g., questionnaire sufficient, domain knowledge test sufficient; the overall score is sufficient). If there was a discrepancy between the scores, individual scores on the SRL questionnaire or the actual score of the domain knowledge test were looked at. There were two main discrepancies. Firstly, students had an insufficient score on the domain knowledge test but a sufficient or above sufficient score on the SRL questionnaire, the

student's overall score was sufficient because it was expected that the student's score on the SRL questionnaire would compensate for the lower score of prior knowledge on the domain knowledge test. Secondly, students had an insufficient score on the SRL questionnaire and a sufficient score on the domain knowledge test, the student's overall score was insufficient because it was expected that the students' level of SRL would be more shown in the collaborative learning assignment than the prior knowledge from the domain knowledge test.

The aim was to get one student that scored an insufficient level, two students that had a sufficient level and one student that had an above sufficient level in each collaboration group. If this was not possible, the researcher looked at the different sum scores of the collaboration groups for the use and availability on the self-regulation score of the SRL questionnaire and the sum scores of the domain knowledge test of the collaboration groups. This was done to make sure that the scores of the participants were evenly distributed amongst the collaboration groups.

Twenty participants from one class participated, and seventeen from the other class. In the first class, five collaboration groups of four students were made, while in the second class, there were three collaboration groups of four students and one collaboration group of five students. Five groups were given a collaboration script, experimental condition (8 girls, 11 boys; M_{age} = 11.47, *SD* = .51), and four groups did not have access to this collaboration script, control condition (11 girls, 5 boys; M_{age} = 11.38, *SD* = .50).

Before data was gathered, the Ethical committee of the University of Twente was asked for permission to conduct this research, the permission was granted in February 2022 (nr: 220079).

3.3 Instrumentation

3.3.1 Questionnaire

To measure the level of individual SRL, the questionnaire that was developed by Sins et al. (2022) which has been analysed and validated, was used. The questionnaire for the students consisted of 34 items, which measured the *use* (G) and *availability* (B) of four self-regulation strategies: planning, retrieving previous knowledge, monitoring time and monitoring learning. Each strategy was measured with four or five items, and all items were measured on a five-point Likert scale. On the items about *use* (G), students indicated how often they do something (1 = never, 2 = rarely, 3 = sometimes, 4 = often, 5 = always). On the items about *availability* (B), students indicated how well they know how to do something (1 = not at all, 2 = not, 3 = somewhat, 4 = well, 5 = very much). An example question related to monitoring time was: *During research, I ask myself: 'Do I still have enough time?'.* This questionnaire was administered via the online survey platform Qualtrics. The complete questionnaire can be found in Appendix A.

From this questionnaire, a score for the *use* and *availability* of each self-regulation strategy was gained. This means that the scores that were scored on each item of a certain regulation strategy were combined to a mean score (e.g., *use* (G) of planning is measured on four items, so the total score of these items was divided by four). The scores of all four self-regulation strategies (planning, retrieving previous knowledge, monitoring time and monitoring learning) were combined to a self-regulation score for the *use* (G) and *availability* (B) (i.e., planning (G) + retrieving previous knowledge (G) + monitoring time (G) + monitoring learning (G) divided by four).

Students scored B+ or G+ if the mean score of the items was ≥ 3.5. Students scored B- or G- if the mean score of the items was < 3.5. These boundaries were determined by Sins et al. (2022). The students were assigned to one of three levels (insufficient, sufficient, and above sufficient). The students were categorised insufficient if they scored B- and G-. Students were categorised sufficient if B or G was scored above or equal to 3.5 and B or G was scored below 3.5 (e.g., B = 3.6; G = 3.2). The students were categorised above sufficient if they scored B+ and G+.

To determine the reliability of the whole questionnaire as well as the scale of self-regulation, Cronbach's Alpha was calculated. For the whole questionnaire, 34 items, Cronbach's α was .88. The scale of self-regulation, the four self-regulation categories combined, showed that for *use*, Cronbach's α was .84, and for *availability*, Cronbach's was α .88.

3.3.2 Domain Knowledge Test

A domain knowledge test was administered, containing nine multiple-choice questions about gravity and space, the topic of the collaborative learning assignment, to measure students' prior knowledge. For each question, one point could be scored. An example question was: *Who is the founder of gravity? (a) Isaac Newton, (b) Albert Einstein or (c) Leonardo da Vinci.* The questions were developed based on information about gravity and space from various websites (e.g., European Space Agency, 2022; ESERO, 2022; NTR, 2013; 2014; Techniek is fun, n.d.) and the school's biology method.

The questions were divided into three kinds of levels, there were three questions for each level. Firstly, questions that the students should know based on prior information about gravity in their biology method. Secondly, questions that required more thinking and knowledge about the topic. Thirdly, difficult questions, that were only expected to know if the students were interested or gained more knowledge (outside school) about gravity and space.

The domain knowledge test was administered on paper and can be found in Appendix B. When students scored a score of 0-3, they were assigned to an insufficient level of prior knowledge because the students should know at least three questions based on information about their biology method. Students who scored a score of 4-6 were assigned to a sufficient level of prior knowledge, it was expected that these students had more knowledge about the topic. Students who scored a score of 7-9

were assigned to an above sufficient level of prior knowledge because they also knew questions that cannot be learned from the biology method and the students were only expected to know the questions if they were interested in gravity and/or space.

3.3.3 Collaborative Learning Assignment

The assignment was created based on a previous lesson series that was developed by the researcher and a designing assignment of Pre-U - University of Twente (Van den Bos, 2020). This assignment was divided into different sub-assignments. At first, there was a classical introduction, students were introduced by the researcher with orientating questions (e.g., How is it possible that everything on earth falls straight down?) and the students watched a video about gravity to get familiar with the concept (NTR, 2014). For the sub-assignments students got an information sheet with the sub-assignment and explanations. For these sub-assignments students could use their Chromebook to find information. It is chosen to provide the students with website links to several websites to gain information about gravity and space. In this way, the students were not spending a lot of time determining whether or not the website provided the correct information. By doing this, the focus lies on the socially shared regulation within the collaboration group and not on how to gain information correctly from the internet.

In the first sub-assignment, students had to find information about gravity, some example questions were given (e.g., Does the moon have gravity as well?) but students could also come up with questions themselves. In the second sub-assignment, students had to investigate if there was gravity in space as well. In the third and last sub-assignment, students had to design their new space station based on information that they found in the previous sub-assignments. This space station had to meet certain requirements (e.g., Three people must be able to live in the space station for a period of six months). The students drew their space station on a big sheet of paper. In the end, they had to explain to the researcher what they did and why they did it, based on the information that they found in sub-assignment one and two. The entire assignment can be found in Appendix C.

3.3.4 Collaboration Script

During the collaborative learning assignment, the experimental condition was aided with a collaboration script. The script was based upon information from various literature and can be found in Appendix D. It was an external script because it was provided by the researcher. In this script, there was a combination of macro and micro-level.

The macro-level was formed by structuring the three phases to establish a chronological order of the activities (initial phase, main phase, final phase). Students were firstly expected to read the introduction of the script. Based on this, the students knew that there were three phases described in

described in the script. This layout was based on the activity pattern of the exemplary collaboration that Rummel and Spada (2005) described in their article, where they describe an initial phase, main phase and final phase, as mentioned before in paragraph 2.3. In the current script, there is an initial phase, main phase, and final phase as well. These phases correspond to the collaborative learning assignment (sub-assignment one, two and three). The initial phase relates to the aspect before the start of the task. The main phase relates to sub-assignments one and two of the collaborative learning assignment, where students gain information for their space station. In the final phase, students design their space station, which relates to sub-assignment three of the collaborative learning assignment.

The micro-level came back by giving detailed action points that the students must do during the three phases to foster the exchange of unshared information. An example of a micro-level point in the main phase is: “Remember that while working on tasks 1 and 2, that you exchange information with each other. Then everyone will understand what it is about”. The detailed action points relate to the theory of Hogenkamp et al. (2021). With these detailed action points, it was tried to foster that the students engage in the subcategories and codes of the theory.

At last, there was a difference between epistemic and social scripts. In the current script, there is a combination of both epistemic and social. The social point of the script came back in the current script by structuring the interaction of the learner. For example: “Tell each other what information you have found.” The epistemic point of the script came back in the current script by guiding the attention of the learners to specific aspects of the task. This was done by structuring the phases that were related to the collaborative learning assignment. And for example, by the following detailed action point: “Remember that you meet the requirements of the space station, does your drawing meet them?”.

3.3.5 Video Recordings

To gain insight into the dialogues of the group members that took place during the collaborative assignment, the assignment was videotaped. Each collaboration group was recorded with a single video camera including a microphone (GoPro Hero 7). Video recording began after the group was instructed to collaborate. To regulate the exact start of the assignment, group members were instructed to speak their names into the camera. The video recording ended when all group members confirmed to the researcher that they had completed the collaborative learning assignment.

3.3.6 Coding Scheme

To measure the level of SSRL that occurred during the assignment, the video recordings were coded using the focused coding scheme (see Table 1) and theoretical model (see Figure 1) developed by Hogenkamp et al. (2021). Based on this, sixteen codes related to four categories: metacognition, cognition, behaviour and motivation.

For this coding ELAN software was used (Sloetjes & Wittenburg, 2008). In total, 726 segments were coded, that were related to the focused coding scheme of Hogenkamp et al. (2021), which included the video data for five collaboration groups that were aided with a collaboration script, and four collaboration groups that were not supported. The level of SSRL was measured on the individual student level. Afterwards, individual results of the group members were combined for the level of SSRL within the groups (to compare the experimental and control condition). The model that was used was created based on data of Van Dijk et al. (2020) to portray the prerequisites and consequences of SSRL. In the study, Van Dijk et al. (2020) investigated the effects of a worksheet that structured a heterogeneous cooperative process. From this study, it appeared that in comparison to the unsupported condition, members of the supported condition participated more equally in the domain-related dialogue, and a larger number of the group dialogue was task-oriented and students managed to spend more on exchanging domain-related explanations. Hogenkamp et al. (2021) created their model by adopting a grounded theory approach (Constructivist approach of Charmaz).

Moreover, it was coded if students were engaged in co-regulation or SSRL because this study focused on SSRL. Based on the definitions that were determined in the theoretical framework, paragraph 2.2, it was coded if students engaged in SSRL or co-regulation.

In order to determine the interrater reliability, a second coder coded 20.7% (N = 150) of the segments using the codes from the focused coding scheme. The interrater reliability (i.e., Cohen's kappa) was considered substantial, $\kappa = 0.68$ (Landis & Koch, 1977). Before proceeding with the analysis, new variables were computed. The codes from the different collaboration groups were computed to overall scores for the different SSRL categories and subcategories.

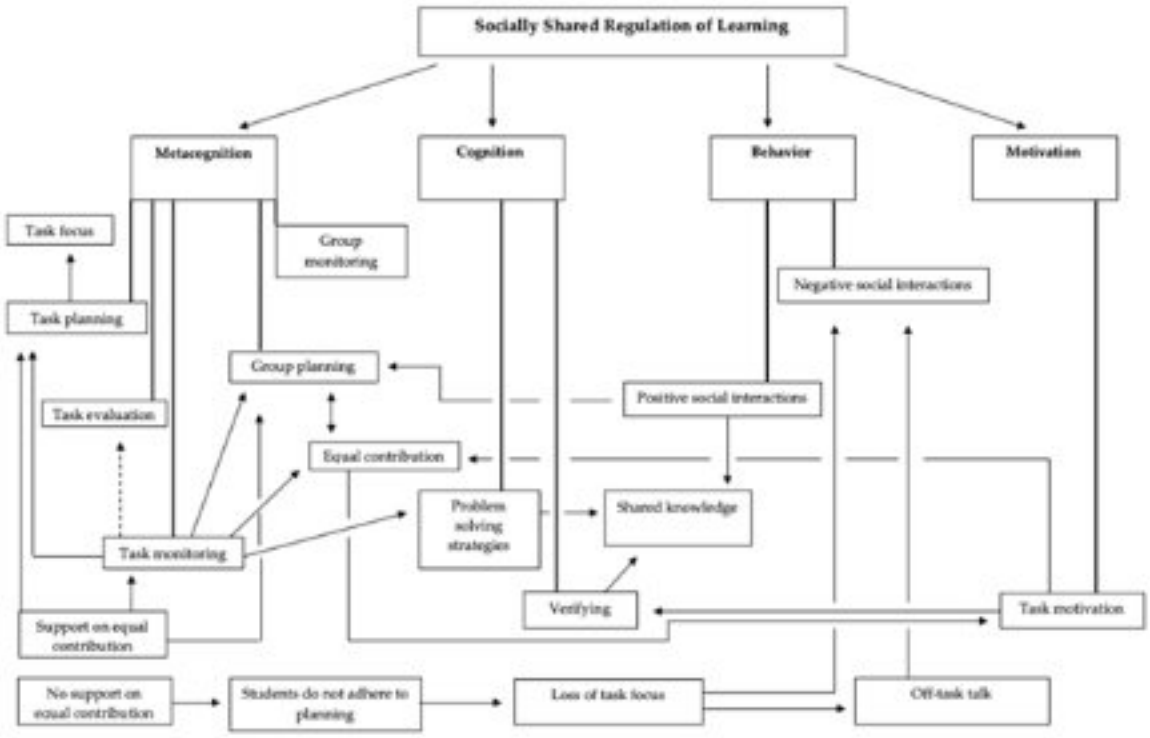
3.4 Procedure

The data gathering was conducted during school hours at the primary school of the students. In total, three sessions with the students were planned in the time span of a month. Before the sessions with the students were executed, a session was planned with the teachers to explain the goals of the current study and plan the data for the sessions with the students. In the first session, the questionnaire about individual self-regulation was administered. This took 30 minutes for each class. Students had their own Chromebook and were placed in a test setting, so they could not cheat. The researcher gave a short introduction by explaining the goals of the total study and explaining the layout of the questionnaire. After this, the students answered the questions. In the second session, the domain knowledge test was administered, this took fifteen minutes per class. The researcher gave a short introduction about the test before the students answered the questions. In the last session, the students performed the collaborative learning assignment. This assignment lasted around 75 minutes. While fulfilling this assignment, the students were video recorded. At first, the researcher gave a

classical introduction to the students about the assignment. What follows, were the sub-assignments where students worked together in their collaboration groups. When the teachers would like to know the outcomes of the study, they could indicate to receive a summary of the important findings.

Figure 1

Theoretical Model of How SSRL is Manifested during Cooperative Learning



Note. Adapted from: Analyzing socially shared regulation of learning during cooperative learning and the role of equal contribution: A grounded theory approach by Hogenkamp et al., 2021, p. 20, Education Sciences.

Table 1

Theoretical Model of How SSRL is Manifested during Cooperative Learning

Code	Description	Example
Goal setting	Setting up or discussing goals for the task	"What is the goal of 'together'?"
Learning strategies	Setting up or discussing learning strategies for the task	"Maybe it is useful if we already write down things for our moon house."
Task perception	Discussing the difficulty of or attitude towards the task	"This is difficult, so we should take that into consideration."
Coordinating collaboration	Arranging task division	"Who wants to start?"
Planning task	Arranging what action, not specifically assigned to a specific person, needs to be performed at a certain point of time	"Now, we need to sign the paper."
Monitoring task progress	Checking progress on the task	"We are at the third step now."
Monitoring task performance	Monitoring how well the group is doing regarding the task	"We already found good aspects for our moon house."
Monitoring group performance	Monitoring how well the group is doing regarding collaborative aspects	"We are collaborating very well!"
Monitoring comprehension	Checking whether the group understands task-related comments or information	"Do you understand what I am saying?"
Evaluating task outcome	Evaluating the outcome of the task	"Do you agree with what is written down on the worksheet?"
Praising	Making positive statements about someone's ideas	"That is a good idea."
Inclusion	Encouraging involvement of group members by asking for ideas and involving them in the task	"We also need to listen to Evy."
Disrespect	Making negative comments about group members or bullying or annoying them	"You are so stupid."

Table 1. *Cont.*

Code	Description	Example
Stimulating task focus	Stimulating group members to work on the task when group members disengage from the task	"Guys, we need to continue with the task."
Correcting behaviour	Controlling the behaviour of group members	"Stop doing that!"
Verifying	Asking group members if provided information is correct	"So, is this what we want to do?"

Note. Adapted from: Analyzing socially shared regulation of learning during cooperative learning and the role of equal contribution: A grounded theory approach by Hogenkamp et al., 2021, p. 7-8, Education Sciences.

4. Results

4.1 Descriptives SRL, Co-Regulation and SSRL

From the SRL questionnaire it became clear that five students' scored for *availability* (B) a high B+, but their score on the *use* (G) was considerably lower (e.g., B = 4.1; G= 2.0, B = 5.0; G =2.1). This was also shown in the mean score of the 37 students (see Table 2). The mean score on the *availability* is higher than on the *use*. In Table 1, the codes and subcodes from the theory of Hogenkamp et al. (2021) were shown. These subcategories did not match all the categories of the SRL questionnaire. Because of this, this study took the self-regulation score on the *use* for the individual level of SRL. It was decided to apply this score because students should show their SRL and not only have the availability.

From the video recordings, it became clear that there were large differences between the use of co-regulation and socially shared regulation of learning during the collaborative assignment for the individual students. In total, 726 segments were coded, SSRL had 36.78% of the codes, whilst co-regulation had 63.22% of the overall codes. In Table 3, only the relative frequencies on the SSRL codes are included, bringing the total number to 100 per cent. The codes related to co-regulation are not included here as well as all other utterances that did not concern SSRL or co-regulation.

Moreover, the mean scores and standard deviations for the total students are shown. A statistical test could show if there is a significant difference between the different categories and students' contribution to SSRL. It also shown that in Table 3 there were less participants in the collaborative assignment than for the SRL questionnaire. The reason for this was the sickness of two students during the collaborative learning assignment.

Table 2

Means and Standard Deviations from SRL Questionnaire

Category	Mean		SD	
	Use	Availability	Use	Availability
Planning	3.34	3.80	.66	.54
Retrieving previous knowledge	3.50	3.83	.70	.73
Monitoring time	3.64	4.01	.59	.64
Monitoring learning	3.22	3.74	.81	.75
Self-regulation	3.42	3.84	.55	.54

Note. *N* = 37

Table 3

Relative Frequency, Means and Standard Deviation for SSRL from the Group Dialogues

Category	Relative frequency (%of all SSRL Codes)	Mean	SD
Metacognition	69.28	5.29	3.81
Cognition	10.86	.83	1.10
Behaviour	17.60	1.34	1.35
Motivation	2.26	.17	.38
Total SSRL	100	7.6	4.64

Note. *N* = 35

4.2 Relationship between SRL and SSRL

To answer the research questions, the data from the SRL questionnaire, domain knowledge test, and video recordings of the collaborative learning assignment were analysed. The first research question was as follows: *"To what extent are students' individual levels of self-regulated learning (SRL) related to their contribution to socially shared regulation of learning (SSRL) during collaborative learning, for Dutch primary school students (grade six)?*". To test the relationship between students'

individual level of SRL, measured with the questionnaire's self-regulation score on the *use* (G) for each individual, and students' individual contribution to SSRL, a Spearman's correlation was carried out. The result showed that there was no statistically significant correlation between students' individual level of SRL and their contribution to SSRL, ρ(35) = .183, *p* = .293.

Despite there being no statistically significant correlation between SRL and SSRL, it was checked if students' individual level of SRL related to students' contribution to the different subcategories (i.e., metacognition, cognition, behaviour, and motivation) of SSRL. Different Spearman correlations were carried out to check this relationship. Individual students' level of SRL was measured with the self-regulation score on the *use* (G). Firstly, it was tested if students' individual level of SRL was correlated with their score on metacognition of SSRL. The results showed that there was no statistically significant correlation between SRL and students' contribution to SSRL on the subcategory metacognition, ρ(35) = .194, *p* = .264.

Secondly, it was tested if students' individual level of SRL was correlated with their score on cognition of SSRL. The results showed that there was no statistically significant correlation between students' individual score of SRL and their contribution to the subcategory cognition of SSRL, ρ(35) = .231, *p* = .182.

Thirdly, it was tested if students' individual level of SRL was correlated with their score on behaviour of SSRL. From the results, it appeared that there was no statistically significant correlation

between students' individual level of SRL and their contribution to the subcategory behaviour of SSRL, ρ(35) = .104, *p* = .554.

At last, it was tested if students' individual level of SRL was correlated with their score on motivation of SSRL. The results revealed that there was no statistically significant correlation between students' individual level of SRL and their contribution to the subcategory motivation of SSRL, ρ(35) = -.274, *p* = .111.

4.3 Individual Differences in Prior Knowledge

For the second research question, "*To what extent do Dutch primary school students (grade six) individual differences in prior knowledge influence their contribution to SSRL?*" it was first checked if there was a correlation between the domain knowledge test and the student's individual contribution to SSRL. It was checked with a scatterplot if the relationship between the variables looked monotonic. From the scatterplot, it appeared that there was no linear relationship, therefore a Spearman's correlation was carried out to check if there was a correlation between the domain knowledge test and the student's individual contribution to SSRL. The results showed that there was no significant correlation between students' prior knowledge and their contribution to SSRL, ρ(35) = .210, *p* = .226.

Secondly, it was checked if the different levels of the domain knowledge test (insufficient level, sufficient level, and above sufficient level) showed statistical differences in their contribution to SSRL. The means and standard deviations of the different levels were shown in Table 4. First, normality (i.e., Shapiro-Wilk test) and homogeneity of variance (i.e., Levene's test) of the three different levels were tested and revealed no violations of these assumptions. Therefore, a One-Way ANOVA was carried out. The results showed that there was no statistically significant difference between the means of the groups and their contribution to SSRL, *F*(2,32) = .703, *p* = .502.

Table 4

Means and Standard Deviations for the Different Levels from the Domain Knowledge test

Level	Mean	SD
Insufficient[a]	2.80	.45
Sufficient[b]	5.11	.92
Above sufficient[c]	7.50	.57
Total	5.05	1.43

Note. [a]*N* = 5. [b]*N* = 26. [c]*N* = 4

4.4 Collaboration Script

The last research question, *"To what extent does an external micro-and macro-level collaboration script with epistemic and social aspects for guiding collaborative learning influence SSRL of Dutch primary school students (grade six)?*" was answered by comparing the experimental condition (*N* = 19), aided with a script, and the control condition (*N* = 16), not aided with a script.

From the video recordings, it became clear that there were large differences in the use of the script between groups that were aided with a script. In two of five groups, the script was used frequently and read at the start of the assignment. On the other hand, in the remaining groups, students had to be encouraged by the researcher to look at the script. It was also shown that groups used the script less frequently when the groups were working on the last phase of the task, the designing of the new space station.

The mean and standard deviation for the experimental and control condition of SSRL can be found in Table 5. First, the normality of the level of SSRL for the experimental and control condition was tested with the Shapiro-Wilk test. The results revealed a violation of this assumption. Therefore, a Mann-Whitney U test was executed to compare the mean ranks of the two conditions. The experimental and control condition total score of SSRL were compared to test if a collaboration script influenced students' contribution to SSRL. The test showed that there were no significant differences between the control condition and experimental condition, $U = 128.5$, $p = .441$.

Table 5

Means and Standard Deviations for the Experimental and Control Condition for SSRL

Condition	Mean	SD
Experimental	7.47	5.37
Control	7.81	3.76
Total	7.63	4.64

Note. *N* = 35

5. Discussion

The aim of this study was to investigate if there was a relationship between students' individual SRL and their contribution to SSRL during collaborative learning for grade six Dutch primary school students. The results first showed that there was a large distinction between the use of co-regulation and SSRL. Students performed more in co-regulation than in SSRL, notably, this was a small part of the total group dialogues that took place during the collaborative learning assignment. Only for the category metacognition, students performed more in SSRL instead of co-regulation.

In addition, the results showed, when only looking at SSRL, that there was no significant correlation between students' individual levels of SRL and their contribution to SSRL. Secondly, this study tested if individual differences in prior knowledge influence students' contribution to SSRL. The results showed that there was no effect of individual differences in prior knowledge on SSRL. Moreover, it was tested if the different levels of the domain knowledge test (insufficient, sufficient, and above sufficient level) showed statistical differences in their contribution to SSRL. The results showed that there were no statistically significant differences between the mean of the groups. Finally, this study investigated if a collaboration script influenced SSRL. The results indicated that there was no significant difference between the control condition and the experimental condition.

5.1 Relationship between SRL and SSRL

According to Panadero et al. (2015), there was a significant relationship between individual SRL and SSRL. The current study hypothesised that students' individual SRL would relate positively to their contribution to SSRL during collaborative learning. However, the findings of the current research were not in line with the research of Panadero et al. (2015) since there was no significant correlation when testing this relationship. Therefore, the hypothesis that was formed could not be confirmed.

It could be argued that the large amount of co-regulation in the codes, and not SSRL, caused that there was no relationship between SRL and SSRL. It might be the case that students need specific training or tools to engage in SSRL. The current study looked at SSRL in face-to-face collaboration. Collaborative learning could also take place in online collaboration, as is done in computer-supported collaborative learning (CSCL). Different tools that aid the process of SSRL have been developed for CSCL (Järvelä et al., 2016). It could be argued that an online and face-to-face collaboration, with CSCL tools, could help students to engage in SSRL. One of the tools that could aid the process is an individual planning tool and a shared planning tool. These tools are intended to encourage SRL and SSRL in collaborative assignments, and to foster the development of skills for regulating collaboration in future assignments (Järvelä et al., 2016).

Moreover, it could be argued that students from grade six were not as well developed in self-regulated learning (SRL) skills and strategies as students from a first-year teacher education study, as in the study of Panadero et al. (2015). To be able to use SRL optimally, it is important to start to offer this in early childhood. It is best not to learn the strategies and skills of self-regulation later than in primary education (Blair & Razza, 2007). It might be the case that the students from the participants' group were not made familiar in their education with regulating their own learning process, and in this way also not familiar with collectively regulating as is done in SSRL. Therefore, it might be needed that students need training in self-regulated learning skills before they could engage in SSRL. One of the training programmes where teachers could encourage students to look at their self-regulatory process is iSelf. iSelf is based on three pillars: "(1) Explicit instruction of self-directed learning (2) integration of the instruction of self-directed learning with the subject matter and (3) connecting to the individual student" (Sins et al., 2019, p. 4). When teachers integrate these three pillars into their teaching, with help of the developed tools, then it is expected that students will train their SRL skills and strategies.

Despite that this research did not show significant results, practically it contributed. In their study, Panadero et al. (2015) stated that future research was needed to examine how differences in individual SRL in groups affect these collaboration processes, and also how to create more balanced learning groups. Panadero et al. (2015) indicated that this could be done by forming heterogeneous groups that are based on different profiles (e.g., high, average, and low self-regulators). The current study contributed to that because the collaboration groups were formed based on the domain knowledge test and SRL questionnaire. It was attempted to get one student that scored an insufficient level, two students that had a sufficient level and one student that had an above sufficient level in each collaboration group. The groups had similar overall scores on the SRL questionnaire and domain knowledge test.

The current research examined differences in SRL and made balanced collaboration groups, this could be used in practice to stimulate the collaboration process and also the appearance of SSRL in collaboration groups.

5.2 Individual Differences in Prior Knowledge

For the second research question, it was hypothesised that there was a relationship between individual differences in prior knowledge and students' contribution to SSRL. In previous research, Winne et al. (2010) stated that prior knowledge is a critical resource that every group member brings to the collaboration. The results from the current study showed that there was no significant correlation between students' prior knowledge and their contribution to SSRL. Secondly, the results showed that there was also no statistically significant difference on students' contribution to SSRL

between the means of the three groups (i.e., insufficient, sufficient, and above sufficient) regarding their level on the domain knowledge test. The hypothesis that was formed could not be confirmed.

Based on the current study, the findings of the study of Winne et al. (2010) have to be questioned because the level of prior knowledge might not be related to the level of SRL and with that also to the students' contribution to SSRL. It could be argued that other individual differences that students bring to a group could influence the students' contribution to SSRL, such as the group members' individual social skills, as Fransen et al. (2011) and Panadero and Järvelä (2015) stated in their studies.

5.3 Collaboration Script

For the third research question, it was hypothesised that the use of a collaboration script would have a positive influence on the students' contribution to SSRL. Hogenkamp et al. (2021) and Järvelä et al. (2015) have shown in their research that students often have a hard time with regulating their collective learning process. A collaboration script could help learners in regulating this process. It was hypothesised that there would be a difference between the collaboration groups who were aided with a collaboration script and collaboration groups who did not have access to this script. However, the results showed that there was no significant difference between the experimental condition, aided with a script, and the control condition. Therefore, the current study is not in line with the research of Rummel and Spada (2005), who argued that a collaboration script could improve the collaborative problem solving and acquisition of knowledge.

In this study, the script that was used was a combination of a micro-level and macro-level script. It could be argued that the micro-level, so the detailed action points, were not detailed enough to structure the collaboration. However, it is debated that micro scripts that are too detailed can hinder students' motivation (Rummel et al., 2009). It also appeared in the video recordings that students first started reading the script, but in a later phase of the task, when students designed the space station, they forgot to follow the action points on the script. It could be that the structuring of the collaborative learning assignment should be changed to foster students to read the script. It is suggested to add prompts in the worksheet of the collaborative assignment, so that students are urged to read the collaboration script.

It might be the case in this study, that the script was not used at its best, but it could also be argued that a script is not the most appropriate support to improve the collaborative process and in this way students' contribution to SSRL. Another solution to improve the collaborative process might be that teachers have to prepare and support students to work together by training their social skills as the development of social skills is essential for group work to be efficient (Buchs & Butera, 2015). This could be done by for example, by modelling how students have to act in a collaboration group.

6. Limitations and Future Research

Although every effort has been made to conduct a transparent and reliable study, several limitations should be taken into account when interpreting the results of this study. Based on these limitations, some possible directions for future research are suggested.

At first, a limitation of the SRL questionnaire was that it did not match all the categories of the theoretical model that was developed by Hogenkamp et al. (2021). The questionnaire mainly focused on the aspects of metacognition and cognition and not on behaviour and motivation. In addition, from the coding of the video recordings, it was also shown that the categories motivation and behaviour, in particular, were more co-regulated than socially shared regulated. This is in line with the research of Hogenkamp et al. (2021). Therefore, the question arises if motivation and behaviour should be included in the model of SSRL. According to Hadwin et al. (2017), coherent and effective co-regulation in a group is likely considered to be necessary for SSRL to take hold. So, if motivation and behaviour are mostly co-regulated they indirectly are necessary for the process of SSRL. Future research should look at how the subcategories of motivation and behaviour should be placed in the concept of SSRL. For future research, it is recommended to include questions in the SRL questionnaire about motivation and behaviour so that more efficient comparisons between the subcategories of SRL and SSRL could be made.

A second limitation is that this study only looked at the individual differences in prior knowledge. From the results of this study, it appeared that there was no relationship between students' prior knowledge and their contribution to SSRL. There are a lot of other differences between students that could be taken into account (e.g., social skills, personality characteristics, prior ability). However, for the current study, because of the time span, it was not achievable to look at more differences between students. For future research, it is suggested to look at other individual differences that could affect how students collaborate in a group. This is in line with the research of Panadero and Järvelä (2015), who stated that it is important to look at the individual differences that students bring to a group. Aspects such as friendship and emotional security could affect the activation of SSRL strategies within a group (Panadero & Järvelä, 2015).

A third limitation is related to the collaboration script. In the current study, an experimental condition and a control condition were compared. The experimental condition was aided with a collaboration script, however, in the video recordings, it was shown that the students partly used it. Schoonenboom (2008) mentioned that a script could be presented to students in different interfaces (e.g., online, offline, particular software), which will have different effects. However, Schoonenboom (2008) stated that most studies make a comparison between the scripted condition and the unscripted condition. There is no comparison made between several representations of the same script. In the current study, in the experimental condition groups were provided with an A4 printed paper with the

script. However, in the video recordings, it was shown that some groups placed the script on a certain table and other groups forgot the script after they read it and it was placed aside. Schoonenboom (2008) mentioned that it is a problem that there is no comparison between several presentations of the script because it does not allow us to find out where the problem of not following the script lies. For future research, it is suggested to look at the way in which a script is most used by students.

7. Conclusion

In conclusion, the present study tested (1) the relationship between students' individual level of SRL and their contribution to SSRL during collaborative learning, (2) if individual differences in prior knowledge influence students' contribution to SSRL, and (3) if a collaboration script for guiding collaborative learning influences SSRL. There were no statistically significant results. It could be argued that the relationships, that were tried to be found in this study, were non-existent. However, the relationship between SRL and SSRL has been found in previous research by Panadero et al. (2015). It is suggested that if the SRL questionnaire involves the categories motivation and behaviour, as the theory of Hogenkamp et al. (2021) does, that a relationship can be found between students' individual level of SRL and their contribution to SSRL.

In this research, prior knowledge did not influence students' contribution to SSRL. It might be the case that prior knowledge is not the most important predictor for individual differences. It is assumed that other individual characteristics play a role in the group process. Therefore, future research should look at for example the social skills that students bring to a group. As mentioned before, teachers could prepare and support students to work together by training their social skills (Buchs & Buttera, 2015).

The use of a collaboration script to aid the collaborative process was also not confirmed in this study. This could be interpreted as that a collaboration script does not affect the collaborative process. However, future research focusing more on the interface and representation of the collaboration script is needed to investigate whether this finding can be supported or not.

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Appendices

Appendix A Questionnaire SRL (Dutch)

Vragenlijst individuele zelfregulatievaardigheden

Start of Block: Introductietekst

Lees eerst deze tekst goed voordat je begint met de vragenlijst.

Je gaat zo een vragenlijst maken. Deze vragenlijst gaat over hoe jij werkt als je onderzoek doet. Met onderzoek doen bedoelen we: Alles wat je doet om uit te zoeken wat het antwoord is op een vraag. Onderzoek doen is bijvoorbeeld: Informatie zoeken of het doen van een proefje.

De vragenlijst meet twee dingen:

(1) Hoe vaak je iets doet.
(2) Hoe goed je weet hoe je iets moet doen.

Soms is het namelijk zo dat je wel goed weet hoe iets moet, maar het niet zo vaak doet. Een voorbeeld: het opruimen van je kamer. Veel mensen weten hoe het moet, maar toch doen ze het niet zo vaak. Soms weet je ook niet zo goed hoe iets moet. Bijvoorbeeld als iets nieuw voor je is, of als iets ingewikkeld is. De vragenlijst begint met een paar algemene vragen. Daarna komen er een aantal stellingen over hoe je werkt als je onderzoek doet.

Start of Block: Algemene vragen

1 Wat is je voornaam?

_____

2 Wat is je achternaam?

_____

3 Ik zit in groep

_____

4 Wat is je leeftijd?

- ○ 9
- ○ 10
- ○ 11
- ○ 12
- ○ 13

5 Wat is je geslacht?

- ○ Jongen
- ○ Meisje
- ○ Anders

Start of Block: Hoe werk je als je onderzoek doet (1 van 4)

6 Hoe vaak doe je dit?

	Nooit	Bijna nooit	Soms	Bijna altijd	Altijd
Voor ik begin aan een onderzoek, kijk ik wat ik eerst ga doen en wat ik daarna ga doen	○	○	○	○	○
Als ik een stap in het onderzoek moeilijk vind, zorg ik dat ik er meer tijd voor heb	○	○	○	○	○
Bij een groot onderzoek, verdeel ik mijn werk over langere tijd	○	○	○	○	○
Voor ik begin aan een onderzoek, kijk ik hoelang ik eraan zal werken	○	○	○	○	○

Page Break

7 Weet je hoe het moet?

	Helemaal niet	Niet	Een beetje	Wel	Helemaal wel
Voor ik begin aan een onderzoek, kijk ik wat ik eerst ga doen en wat ik daarna ga doen	○	○	○	○	○
Als ik een stap in het onderzoek moeilijk vind, zorg ik dat ik er meer tijd voor heb	○	○	○	○	○
Bij een groot onderzoek, verdeel ik mijn werk over langere tijd	○	○	○	○	○
Voor ik begin aan een onderzoek, kijk ik hoelang ik eraan zal werken	○	○	○	○	○

Start of Block: Hoe werk je als je onderzoek doet (2 van 4)

8 Hoe vaak doe je dit?

	Nooit	Bijna nooit	Soms	Bijna altijd	Altijd
Voor ik begin aan een onderzoek, vraag ik me af: 'Waarover gaat het onderzoek? Wat weet ik al over dit onderwerp?'	○	○	○	○	○
Voor ik begin aan een onderzoek, vraag ik me af: 'Heb ik al eerder iets gelezen of gehoord over dit onderwerp?'	○	○	○	○	○
Voor ik begin aan een onderzoek, vraag ik me af: 'Heb ik al eerder iets over dit onderwerp geleerd?'	○	○	○	○	○
Voor ik begin aan een onderzoeksopdracht, vraag ik me af: 'Heb ik zo'n opdracht al eens eerder gemaakt?'	○	○	○	○	○
Als ik een onderzoeksopdracht moet doen die ik al eens gedaan heb, vraag ik me af: 'Hoe heb ik het toen gedaan? Was dat een goede manier?'	○	○	○	○	○

Page Break

9 Weet je hoe het moet?

	Helemaal niet	Niet	Een beetje	Wel	Helemaal wel
Voor ik begin aan een onderzoek, vraag ik me af: 'Waarover gaat het onderzoek? Wat weet ik al over dit onderwerp?'	○	○	○	○	○
Voor ik begin aan een onderzoek, vraag ik me af: 'Heb ik al eerder iets gelezen of gehoord over dit onderwerp?'	○	○	○	○	○
Voor ik begin aan een onderzoek, vraag ik me af: 'Heb ik al eerder iets over dit onderwerp geleerd?'	○	○	○	○	○
Voor ik begin aan een onderzoeksopdracht, vraag ik me af: 'Heb ik zo'n opdracht al eens eerder gemaakt?'	○	○	○	○	○
Als ik een onderzoeksopdracht moet doen die ik al eens gedaan heb, vraag ik me af: 'Hoe heb ik het toen gedaan? Was dat een goede manier?'	○	○	○	○	○

Start of Block: Hoe werk je als je onderzoek doet (3 van 4)

10 Hoe vaak doe je dit?

	Nooit	Bijna nooit	Soms	Bijna altijd	Altijd
Tijdens een onderzoek, vraag ik me af: 'Heb ik nog genoeg tijd?'	○	○	○	○	○
Tijdens een onderzoek, kijk ik tussendoor wat ik al gedaan heb	○	○	○	○	○
Tijdens een onderzoek, kijk ik tussendoor hoeveel ik nog moet doen	○	○	○	○	○
Tijdens een onderzoek, volg ik mijn planning	○	○	○	○	○

11 Weet je hoe het moet?

	Helemaal niet	Niet	Een beetje	Wel	Helemaal wel
Tijdens een onderzoek, vraag ik me af: 'Heb ik nog genoeg tijd?'	○	○	○	○	○
Tijdens een onderzoek, kijk ik tussendoor wat ik al gedaan heb	○	○	○	○	○
Tijdens een onderzoek, kijk ik tussendoor hoeveel ik nog moet doen	○	○	○	○	○
Tijdens een onderzoek, volg ik mijn planning	○	○	○	○	○

Start of Block: Hoe werk je als je onderzoek doet (4 van 4)

12 Hoe vaak doe je dit?

	Nooit	Bijna nooit	Soms	Bijna altijd	Altijd
Voor ik begin aan een onderzoek, denk ik na over mijn doelen	○	○	○	○	○
Tijdens een onderzoek, vraag ik me af: 'Lukt het goed op deze manier?'	○	○	○	○	○
Tijdens een onderzoek, vraag ik me af: 'Begrijp ik nog alles?'	○	○	○	○	○
Tijdens een onderzoek, vraag ik me af: 'Wat vind ik moeilijk? Wat moet ik nog eens oefenen?'	○	○	○	○	○

13 Weet je hoe het moet?

	Helemaal niet	Niet	Een beetje	Wel	Helemaal wel
Voor ik begin aan een onderzoek, denk ik na over mijn doelen	○	○	○	○	○
Tijdens een onderzoek, vraag ik me af: 'Lukt het goed op deze manier?'	○	○	○	○	○
Tijdens een onderzoek, vraag ik me af: 'Begrijp ik nog alles?'	○	○	○	○	○
Tijdens een onderzoek, vraag ik me af: 'Wat vind ik moeilijk? Wat moet ik nog eens oefenen?'	○	○	○	○	○

Start of Block: Einde van de vragenlijst

Dit was het einde van de vragenlijst. Als je nog opmerkingen hebt over de vragenlijst, kan dat hieronder. Zo niet, dan kun je de vragenlijst afsluiten. Bedankt voor het meedoen aan mijn onderzoek!

Appendix B Domain knowledge test (Dutch)

Vragenlijst voorkennis

Naam:
Groep:

Je gaat zo een vragenlijst invullen die jouw voorkennis test over het onderwerp die je tijdens de groepsopdracht gaat uitvoeren. Er komen negen vragen die kijken wat je al weet van het onderwerp. Het is helemaal niet erg als je iets nog niet weet, dit ga je namelijk leren tijdens de opdracht.

1. Wat is zwaartekracht?

- De kracht die ontstaat als twee voorwerpen over elkaar schuiven
- Een aantrekkende kracht die twee of meerdere voorwerpen naar elkaar toe trekt
- De kracht die een bewegend voorwerp uit de bocht duwt

2. Wie is de ontdekker van de zwaartekracht?

- Isaac Newton
- Albert Einstein
- Leonardo da Vinci

3. Wat is gewicht?

- Gewicht is de kracht die het kost om iets vooruit te krijgen
- Gewicht is hoeveel iets weegt
- Gewicht is de kracht waarmee het ene voorwerp tegen het andere drukt

4. Wat is massa?

- De kracht waarmee het ene voorwerp tegen het andere drukt
- Massa is de hoeveelheid dat je van een voorwerp hebt
- Het product van lengte, breedte en hoogte

5. Wat kan er met je lichaam gebeuren door het gebrek aan zwaartekracht?

- Je spieren worden slap en de kalk gaat uit je botten
- Je hart gaat langzamer kloppen
- Je longen moeten harder werken

6. Hoe lang doet de aarde over een rondje om haar eigen as?

- 24 uur
- Eén maand
- 365 dagen

Ga naar de volgende pagina!

7. Waarom is een astronaut gewichtloos?

- Doordat de maan de zwaartekracht aantrekt
- Het ruimtestation waarin ze leven verkeert de hele tijd in vrije val
- Het ruimtepak zorgt ervoor dat ze gewichtloos zijn

8. Wat is de belangrijkste taak van een astronaut?

- Ze oefenen met gewichtloosheid
- Ze zijn opzoek naar nieuwe planeten en sterren
- Ze doen onderzoek en experimenten

9. Wie was de eerste man op de maan?

- Neil Armstrong
- Andre Kuipers
- William Bell

Einde

Appendix C Collaborative learning assignment (Dutch)

Zwaartekracht en de ruimte

De onderzoeker zal de inleiding aan de leerlingen geven. Na de inleiding gaan de leerlingen, in de kern, in hun samenwerkingsgroepjes aan de slag.

Inleiding (klassikaal, samenwerkingsgroepjes zitten bij elkaar):

Er staan oriënterende vragen op het bord (d.m.v. PowerPoint):

- Hoe komt het dat wij bij Australië niet van de aarde afvallen?
- Hoe kan het dat op aarde alles recht naar beneden valt?
- Waarom zijn alle vallende voorwerpen een tijdje gewichtloos?
- Hoe komt het dat een appel naar beneden valt?

Vervolgens wordt er door de onderzoeker gevraagd aan de leerlingen: Weet iemand waardoor dit komt? Antwoord: zwaartekracht.

De onderzoeker laat een filmpje zien van Isaac Newton over zwaartekracht:
https://schooltv.nl/video/wie-was-isaac-newton-uitvinder-van-de-zwaartekracht/

De onderzoeker geeft aan dat de leerlingen zometeen bezig gaan in hun groepjes. Er zijn hierbij drie opdrachten die zij gaan uitvoeren. De tijd waarop de leerlingen klaar moeten zijn met de opdracht wordt afgesproken. Voordat de leerlingen starten met het werkblad moeten zij om de beurt hun naam in de camera spreken, om de start van de samenwerking aan te geven. Daarna kunnen zij starten met de opdrachten. De onderzoeker geeft aan dat zij zo weinig mogelijk zal helpen.

***Kern*:**

Onderstaande informatie komt op het werkblad van de leerlingen te staan:

Stel je voor dat over tien jaar het International Space Station (ISS) niet meer bestaat, dan moet er een nieuw ruimtehuis komen voor de astronauten. Dit ruimtehuis gaan jullie samen ontwerpen, maar daarvoor hebben jullie wel eerst informatie nodig. Die informatie gaan jullie verzamelen in opdracht 1 en 2. In opdracht 3 gaan jullie het ruimtehuis ontwerpen. Mochten jullie eerder klaar zijn met de derde opdracht, roep mij er dan even bij. Dit moet uiterlijk vijf minuten voordat de tijd om is zijn**. De eisen van het ruimtehuis staan bij opdracht 3 beschreven. Hier moeten jullie dus goed aan denken!** In Teams, op de Chromebook, staat een document waar jullie bruikbare links kunnen vinden naar websites en video's, om zo informatie te verzamelen.

1. Informatie opzoeken over zwaartekracht. Je mag ook andere vragen toevoegen en je hoeft niet alle voorbeeldvragen te beantwoorden.

Voorbeeldvragen:

- Wat is het?
- Wie heeft het ontdekt?
- Wat zijn de drie wetten die de ontdekker heeft?
- Wat is massa en wat is gewicht (wat heeft dit te maken met zwaartekracht)?
- Waar komt het voor?
- Heeft de maan ook zwaartekracht?

1. Onderzoeken of je in de ruimte ook zwaartekracht hebt

Kijk hierbij goed naar het verschil tussen de ruimte en het International Space Station (ISS). En het verschil tussen gewichtloosheid en zwaartekracht.

2. Ontwerp een nieuw ruimtehuis (een nieuw ISS) waarin een astronaut kan leven.

Denk hierbij aan de kennis over de zwaartekracht. Daarnaast kunnen jullie ook informatie opzoeken over het leven in het huidige ISS. Tijdens het ontwerpen mogen jullie nog steeds gebruik maken van je Chromebook om informatie op te zoeken. Het uiteindelijke ontwerp van het ruimtehuis moet een tekening zijn op het grote blad waarin jullie kort opschrijven wat er te zien is. Zorg ervoor dat jullie straks aan mij kunnen uitleggen wat jullie hebben gemaakt en waarom jullie dat hebben gemaakt.

Eisen voor het ruimtehuis:

- Er moeten drie mensen kunnen leven voor een periode van zes maanden.
- Deze mensen moeten er kunnen wonen (slapen, eten, persoonlijke hygiëne) en werken (onderzoeken kunnen uitvoeren).
- Zorg voor water en zuurstof in het huis.
- Deze personen moeten naar het ruimtehuis, maar na een periode van 6 maanden ook weer terug. Hoe gebeurt dit?

De volgende stappen kunnen jullie gebruiken om het ruimtehuis te ontwerpen.

- Probleem verkennen:
  Hoe kan de mens eten? Hoe kan de mens bewegen? Hoe komt het ruimtehuis bij de planeet en weer terug naar aarde? Hoe gaat het nu in het ISS? Jullie schrijven alle vragen op die in je op komen.
- Ideeën verzinnen en selecteren:
  Jullie geven globaal antwoord op de vragen die jullie hebben opgesteld.
- Concept uitwerken en selecteren:
  Op basis van de antwoorden schrijven jullie op hoe jullie ruimtehuis er uit moet komen te zien
- Prototype maken:
  Jullie gaan een tekening maken op het grote blad waarin jullie opschrijven wat er te zien is. Zorg ervoor dat je straks aan mij kan uitleggen wat jullie hebben gemaakt en waarom jullie dat hebben gemaakt. Op welke informatie die jullie verzameld hebben, is dat gebaseerd?

Links die tijdens de opdrachten gebruikt kunnen worden, je kan daarnaast ook zelf op zoek naar informatie:

- Zwaartekracht
https://wikikids.nl/Zwaartekracht
- Weten van Newton
https://wikikids.nl/Wetten_van_Newton
- Isaac Newton
https://schooltv.nl/video/wie-was-isaac-newton-uitvinder-van-de-zwaartekracht/

- Ruimte en zwaartekracht
https://www.natuurkunde.nl/artikelen/684/zwaartekracht#:~:text=Dat%20lijkt%20misschien%20wel%20zo,ben%20je%20bepaald%20niet%20gewichtloos.

- Zwaartekracht een kwestie van aantrekking
https://www.nemokennislink.nl/publicaties/zwaartekracht-een-kwestie-van-aantrekking/
- De maan, de aarde en zwaartekracht
https://www.esa.int/kids/nl/leren/Ons_Heelal/Hoe_ontstond_het_heelal/De_maan_de_aarde_en_zwaartekracht
- Gewichtloosheid
https://wikikids.nl/Gewichtloosheid
- Massa en gewicht
https://techniekisfun.weebly.com/uploads/5/1/8/2/51828029/massa_en_gewicht_tif.pdf
- Massa
https://wikikids.nl/Massa_(natuurkunde)
- Gewicht
https://nl.wikipedia.org/wiki/Gewicht
- Wat weer jij over de ruimte?
https://quiz.ntr.nl/quiz/start/quiz_id/159
- De buitendienst- astronauten
https://schooltv.nl/files/PROGRAMMA/Basisonderwijs/DeBuitendienst/Astronauten.pdf
- Douchen is een hele opgave in de ruimte
https://www.youtube.com/watch?v=0MbNJBZRVFk
- Wat is het ISS?
https://schooltv.nl/video/wat-is-het-iss-het-internationale-ruimtestation/#q=wat%20is%20het%20iss
- Het leven aan boord van ISS
https://schooltv.nl/video/leven-aan-boord-van-iss-een-ruimtestation-zo-groot-als-een-voetbalveld/
- Internationaal ruimte station ISS
https://wikikids.nl/Internationaal_ruimtestation_ISS
- Leven in de ruimte – klik op leven in de ruimte nadat je de link hebt geopend
https://www.esa.int/kids/nl/leren
- Leven in de ruimte 2
https://www.esa.int/Science_Exploration/Human_and_Robotic_Exploration/Lessons_online/Leven_in_de_ruimte
- Gewichtloosheid in het ruimtestation
https://www.astronomie.nl/veelgestelde-vragen?category=Vragen+over+ruimtevaart

Appendix D Collaboration script (Dutch)

Dit blad gaat jullie helpen tijdens het maken van de opdracht en het samenwerken. Er staan drie fasen op dit blad beschreven.

1. Voor het werken aan de opdracht (startfase)
2. Tijdens het werken aan opdracht 1 en 2 (hoofdfase)
3. Werken aan opdracht 3 (eindfase)

Tijdens deze opdrachten moeten jullie ervoor zorgen dat iedereen aan het woord komt en dat iedereen werkt aan de opdracht én het eens is over het eindproduct.

1. **Startfase**

- Start met het lezen van het informatieblad en lees dit hulpblad scannend door. Zijn er moeilijke opdrachten?

- Bepaal wat jullie deze les moeten doen. Begrijpt iedereen de opdracht?

- Denk aan de tijd die jullie van mij (Esmee) hebben gekregen.

Kunnen jullie alles allemaal samen maken?

2. **Hoofdfase**

- Denk eraan dat je tijdens het werken aan opdracht 1 en 2 informatie met elkaar uitwisselt. Dan snapt iedereen waar het over gaat!

- Denk eraan dat je tussendoor let op hoe het gaat met je opdracht, denk aan de tijd die je hebt en de opdrachten die je moet maken

- Denk eraan dat je eens kijkt bij je groepsgenoten.

- Vertel aan elkaar welke informatie jullie hebben gevonden

3. **Eindfase**

Samen hebben jullie de informatie verzameld. Nu gaan jullie bezig met de eindopdracht, het maken van een ruimtehuis.

- Denk eraan dat iedereen het eens moest zijn over het eindproduct

- Denk eraan dat je voldoet aan de eisen van het ruimtehuis, voldoet jullie tekening daaraan?