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What kind of challenges teacher students experience in collaborative learning and how they solve the challenges?

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What kind of challenges teacher students experience in collaborative learning and how they solve the challenges?			
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<p>Opettajankoulutuksella on merkittävä rooli koulujen pedagogisen kulttuurin kehittämisessä. Teknologian nopea kehitys, työelämän muutokset ja oppimistieteellinen ymmärrys oppimisen prosesseista ovat asettaneet koulutuksen kehittämislle uusia haasteita. Jotta opettajaopiskelijat olisivat valmiita opettamaan 2000-luvun oppimistaitoja ja muuttamaan pedagogista ajatteluaan, he tarvitsevat myös itse kokemuksia yhteisöllisestä oppimisesta ja ymmärrystä yhteisöllisen oppimisen mekanismeista.</p> <p>Yhteisöllinen oppiminen määritellään koordinoituna toimintana, jossa pienryhmät ratkaisevat ongelmia ja rakentavat tietoa yhdessä. Onnistuakseen yhteisöllisessä oppimisessä, ryhmän tulee koordinoita ja säädellä oppimisprosessiaan. Haasteet voivat haitata ryhmän oppimista, mutta samalla ne voivat toimia keskeisenä strategisen oppimisen aktivoivana mekanismina. Oppimisen sosiaalisesti jaettu säätely on ryhmätasolla tapahtuvaa, opiskelijoiden itsensä hallinnoimaa oppimistoiminnan suunnittelua, tarkkailua ja arviointia, joka tapahtuu yhteisöllisen oppimisen kontekstissa.</p> <p>Tutkielman tavoitteena on analysoida, millaisia haasteita opettajaopiskelijat kohtaavat yhteisöllisessä oppimisessä ja kuinka paljon eri ryhmillä on haasteita, sekä antaa kuvaileva esimerkki siitä miten valittu ryhmä ratkaisee kohtaamansa haasteet. Aineisto on kerätty osana PREP21-projektia. Tutkielmassa on toteutettu laadullinen videoaineistoanalyysi haasteista, sekä kuvaileva case-esimerkki haasteiden ratkaisemisesta ryhmässä. Opiskelijoiden työskentelyä kuvattiin viiden viikon mittaisella ympäristö- ja luonnontiedon kurssilla. Tulosten mukaan opiskelijat kohtasivat eniten haasteita sisällön ymmärtämiseen ja kiinnostuksen ylläpitoon liittyen. Lisäksi opiskelijoilla oli haasteita vuorovaikutuksessa ja työn organisoimisessa, sekä työskentelyyn vaikuttaneita ulkoisia haasteita. Haasteiden määrän ja laadun vertailu eri ryhmien välillä toi esille, miten toisilla haastemäärät ja –tyypit vaihtelivat paljon tilanteiden välillä, mutta toisilla samat haasteet esiintyivät useissa tilanteissa. Esimerkiksi haasteiden ratkaisusta valittiin tilanne, jossa oli paljon haasteita ja haastetyypit tukivat mahdollisuutta jaetun säätelyn esiintymiselle. Ryhmä onnistui ratkaisemaan haasteet ja tilanteesta löytyi useita esimerkkejä säätelystä. Johtopäätöksenä opiskelijat tarvitsisivat tukea keskittymisen ylläpitoon, sisällön ymmärtämiseen ja teknologian käyttöön liittyvien haasteiden ratkaisussa, jotta esiintyvät haasteet tukisivat oppimista yhteisöllisen tiedonrakentelun kannalta. Jotta opettajat voisivat työssään toteuttaa yhteisöllistä oppimista, he tarvitsevat käytännön ymmärrystä erilaisista haasteista, jotka haittaavat ja edesauttavat oppimista sekä siitä, miten oppilaat ohjailevat oppimistaan ja milloin ryhmät tarvitsevat tukea.</p>			
Asiasanat yhteisöllinen oppiminen, luokanopettajakoulutus, oppimisen sosiaalisesti jaettu säätely, haasteet			

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Teacher education is a powerful channel for changing pedagogical culture to respond better for the needs that fast development of technology, changes in the working life, and new understanding about learning, have brought for the education. To be able to teach 21<sup>st</sup> century skills and collaborative learning, and change their pedagogical thinking, teacher students need to experience the new pedagogical culture themselves as students and to understand the mechanisms of collaborative learning.

Collaborative learning is defined as coordinated activity, where small groups of students solve problems and construct knowledge together. To be successful in collaborative learning, students must coordinate and regulate their learning process. Challenges may interrupt group learning, but they also work as an important mechanism to activate regulation of learning. Socially Shared Regulation of Learning (SSRL), is a group-level form of regulation, which happens in the context of collaboration.

The aim of this study is to analyze, what kind of challenges teacher students face in their collaborative learning, how much challenges different groups have and to describe as an example, how the case group solves their challenges during the selected session. Data of this study has been collected as part of the PREP21-project, preparing teachers students for 21<sup>st</sup> century learning practices, ways of thinking and ways of working. This study is a qualitative video data analysis about the challenges in small groups of teacher students in collaborative learning during five weeks' course of environmental science. Results of this study shows, that students face most often challenges in understanding of the content and challenges to maintain their interest. Students had also challenges in interaction and organizing work and external challenges where technology and external interruptions affected for groups work. The groups who had mostly challenges in understanding and interaction, did not have so many challenges in participation, and the group who had many external challenges and challenges participation, did not have so many challenges in understanding. The comparison of challenges amounts and challenge types between the groups pointed out how challenge amounts and types varied a lot in some groups, while in other groups same challenge types occurred in several situations. The case group was chosen based on the high amount of challenges and the challenge types occurring in the case example. Group managed to solve their challenges and several examples were found and described about SSRL.

As a conclusion, it seems that teacher students could be supported in solving the challenges in participation and external challenges to optimize the challenges to support shared knowledge construction better. To be able to design and support collaborative learning process, teacher students need practical level understanding about what kind of challenges interrupt learning and what kind of challenges promote learning. Understanding about the regulation helps educators to recognize where and when groups need support and what kind of task-design promotes regulation in collaboration.

Asiasanat collaborative learning, Socially Shared Regulation of learning, challenges, teacher education

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## **1 Introduction**

Teacher education has not been able to follow the societal changes and make changes to its teaching processes accordingly, but it has potential to be a powerful channel to change pedagogical culture (Häkkinen, Mäkitalo-siegl, Järvelä, Ahonen, Näykki, Valtonen, 2016). The fast development of modern technology and rapidly developing working life has brought the need of teaching 21<sup>st</sup> century skills at schools (Binkley, Erstad, Herman, Raizen, Ripley, Miller-Ricci & Rumble, 2012). 21<sup>st</sup> century skills are defined as skills for learning, creative thinking, collaboration and the ability to utilize ICT (Binkley, et al., 2012). In Finland, the new core curriculum 2014 has prioritized learning of 21<sup>st</sup> century skills and the use of different methods that have their base on social learning and knowledge construction (Opetushallitus, 2014). Implication of the new curriculum started in autumn 2016, but early experiences from the implementation describe, that execution of the new pedagogical practices is often on the responsibility of teachers themselves and their competencies and motivation vary a lot.

Teacher students have good chances to make the change in teaching culture, but they first need to adapt to the change themselves as students (Häkkinen, et al., 2016). Positive experiences about collaborative learning, which is pedagogically designed, supported and it enhances students' collaborative skills, builds a good basis for future teachers to implement collaborative learning in their pedagogy as well. Some of the teacher students have strong potential for critical thinking and collaborative learning culture, but still many of the students have gone through the traditional education themselves, which means that they do not necessarily have a strong basis in 21<sup>st</sup> century skills (Häkkinen et al., 2016). Collaborative learning is defined as one of the 21<sup>st</sup> century learning skills and collaborative skills have been measured in PISA since 2015 (Häkkinen et al., 2016). Social skills, ability to commit to joint work and to coordinate it with peers, are necessary skills in everyday learning environments (Häkkinen et al., 2016). Besides the important role of collaborative skills from the aspect of learning itself and from the aspect of changing the working culture, students seem to enjoy collaborative learning (O'Donnell & Hmelo-Silver, 2013). Finnish secondary school students also rank collaboration the highest in importance when 21<sup>st</sup> century skills are listed (Ahonen & Kinnunen, 2014). Finnish schools are also developing new collaborative practices for teachers, such as models to teach together, to support teachers' development in their profession and to support well-being of teachers and students at schools (Rajakaltio, 2014).

Collaborative learning is a social approach for learning, in which students work together to solve an ill-structured task by coordinating their learning together and aiming to construct a shared understanding about the topic (O'Donnell & Hmelo-Silver, 2013). Challenges in collaborative learning play an important role in activating students' strategic learning skills such as their own problem exploration and regulation of learning (Häkkinen et al., 2016; Hadwin, Järvelä & Miller, 2011). To activate strategic learning skills, students need to be aware of the faced challenges and they must put an effort into solving the challenges (Näykki, Isohätälä, Järvelä, Pöysä-Tarhonen & Häkkinen, submitted). There is a need to understand better, what kind of challenges teacher students face in their collaborative learning and how they solve different challenges. Research about how groups solve their challenges in the context of collaborative learning is called research about Socially Shared Regulation of Learning (Hadwin et al., 2011). The research field is still emerging (Panadero & Järvelä, 2015) and more common-level examples about the phenomenon would be needed in educating educational practitioners. For teacher students, it is important to understand the central mechanisms of collaborative learning. Understanding about the regulation of learning helps teachers to design pedagogical solutions, which support students to develop their regulation skills.

This thesis is based on the data that have been collected as a part of the PREP21 project. The general aim of the PREP21 –research project is to provide knowledge on how to develop teacher education to be more productive and ready to react to challenges of the learning society and the future of schooling (Häkkinen et al., 2016). Project aims to support teacher students in three core skill areas which are strategic learning skills, collaborative problem solving skills and skills in integrating pedagogy and technology (Häkkinen et al., 2016). The aim of this thesis is to explore collaborative learning and particularly, to describe the different challenges that five groups of teacher students face during five sessions of collaborative learning in their environmental science course. This thesis also presents a case example of how a small group solves their challenges during one session of collaborative learning. Thus, this study complements the understanding of the current state of teacher students' collaboration skills in the learning setting which is designed to promote collaboration, problem-solving and regulatory processes of teacher students.

## **2 Theoretical framework**

This chapter presents a definition of collaborative learning and explain its' benefits for learning. After that, it is described why collaborative learning is challenging and what kind of challenges previous studies have found. In the third part of the chapter, the concept of Socially shared regulation is presented and the role of it in collaborative learning is explained.

### **2.1 Collaborative learning**

Collaborative learning is a social approach for learning, which has been defined as a coordinated and synchronous attempt to construct and maintain shared understanding of the task (O'Donnell & Hmelo-Silver, 2013; Roschelle & Teasley, 1995). Collaborative learning can be separated from other forms of group learning, such as cooperative learning by its' goals, coordination and the aim of shared understanding of the content and of the task (O'Donnell & Hmelo-Silver, 2013; Dillenbourg, 1999). In collaborative learning, students engage in a shared knowledge construction process, in which knowledge is constructed reciprocally in interaction (Arvaja, Salovaara, Häkkinen & Järvelä, 2007). In social interaction, students elaborate and share different perspectives, and increase their understanding during learning more than they could do individually (Dillenbourg, 1999). The goal of collaborative learning is a mutual product of learning and a shared understanding about the topic (O'Donnell& Hmelo-Silver, 2013). To understand collaborative learning, the relations of situation, interaction, processes of collaboration and the effects of these four factors must be considered (Dillenbourg, 1999).

The tasks in collaborative learning are often ill-structured and the roles of the group members are equal and interdependent when group is solving the task (O'Donnell & Hmelo-Silver, 2013; Dillenbourg, 1999). One central feature of collaborative learning is the way the work is shared between the group members. Students focus on different levels of the task and therefore solve it collectively, rather than work individually with separated parts of the task (Dillenbourg, 1999). The roles between group members group can change quickly and naturally during the work. This causes the need for group members to monitor one another's work and communicate with each other's about what they are doing (Dillenbourg, 1999). All group members work equally, but the tasks are interdependent, so when students are solving their tasks, they similarly change their thoughts and ideas, and co-construct a shared

understanding of the given topic (Dillenbourg, 1999; O'Donnell & Hmelo-Silver, 2013). Thus, students need to be aware of what other group members do and what the responsibilities of each person are.

Since knowledge construction is an interpersonal phenomenon, which happens reciprocally in interaction, the quality of collaborative learning is studied through interaction between group members (Arvaja et al., 2007; Barron, Pea & Engle, 2013). Different cognitive, relational, personal, and contextual features interact in collaborative learning (Barron, et al., 2013). The way in which interaction develops in collaborative learning depends on how involved the individuals are, how they understand the activity, the available material, and the symbolic resources, but also about how they implicitly and explicitly participate and promote joint work (Barron et al., 2013). The quality of interaction is not defined only by the frequency of interactions, but rather to what extent it affects the group members' cognitive processes (Dillenbourg, 1999).

## **2.2 Situative perspective in collaborative learning**

Situative perspective explains how the role of social has been understood in learning and regulation. Differing from previous perspectives of social learning (socio-cognitive and sociocultural perspectives), situative perspective combines individual and social aspects in explaining what the role of social processes for learning is (Järvenoja, Järvelä & Malmberg, 2015).

The aspect of people learning by engaging in activity systems has been considered as a basis in modern learning sciences (Greeno & Engeström, 2014). The main claim in situative perspective is that all cognition occurs as activity within the system, which means that the focus is not only in the individual, but in the entire system consisting for example of a group of people (Schoor et al., 2015; Greeno & Engeström, 2014). In activity systems individuals interact with different kinds of components in their environment. Activity system can be, for example, a classroom with a teacher and the students, or an individual interacting with a virtual learning environment (Greeno & Engeström, 2014). In this study, the focus of the research is a small group, where participants of the group interact within their learning environment. Situative perspective as a theoretical perspective means that learning is analyzed in the same context where it happens (Greeno & Engeström, 2014). In social learning situations, the meanings of actions are negotiated and co-constructed among group members



in the context of the group rather than just individual processes influenced by others. Thus, the benefits of collaboration are understood as different, collective learning results which also include interaction. There is an assumption that patterns of discourse and the distal outcomes of learning have a mediated relationship (Enyedy & Stevens, 2014). This means that the quality of the group interaction during collaborative learning offers one aspect on how well the groups perform in each collaborative task. Another aspect of the quality of collaborative learning are the group members' perceptions about the interaction.

### **2.3 Challenges in collaborative learning**

Learners can face many different challenges during collaborative learning sessions (i.e. Van den Bossche, Segers & Kirschner, 2006; Järvelä, Volet & Järvenoja, 2010). Students must coordinate their learning, negotiate about multiple perspectives, bring together different expectations towards learning, different values and experiences and different perceptions of the atmosphere in the group and therefore collaborative learning is quite complex (Järvelä et al., 2010). Previous studies have described challenges in cognitive (Van den Bossche et al. 2006), motivational (Järvelä et al., 2010; Rogat, Linnenbrink-Garcia & DiDonato, 2013), social (Arvaja et al., 2007) and socio-emotional processes of learning (Barron, 2003; Näykki, Järvelä, Kirschner & Järvenoja, 2014). In addition to these processes of learning, previous research has described external constraints (Järvelä & Järvenoja, 2009).

Challenges in cognitive processes are connected to difficulties in sharing knowledge construction processes, negotiating and integrating different perspectives and in understanding another person's thinking (Van den Bossche et al., 2006; Järvelä et al., 2010). Cognitive challenges occur in collaborative learning for example as shallow knowledge construction, challenges in understanding a task or content, or as challenges in the use of cognitive strategies (Koivuniemi et al., 2017). Not all the cognitive challenges inhibit or interrupt learning but some of them are understood as an important part of the group learning process. According to the socio-cognitive approach for learning, socio-cognitive conflict is one of the core mechanisms of shared knowledge construction (Arvaja & Mäkitalo-Siegl, 2006). When students present different perspectives and ideas, they become aware of differences between their thinking and of the gaps in their knowledge. By argumenting their aspects and solving the socio-cognitive conflict, students learn effectively (Arvaja & Mäkitalo-Siegl, 2006). Because critical discussions and argumentation may include a risk to

raise socio-emotional challenges in a group, balance is needed between socio-emotional processes and critical discussions to optimize learning results (Isohätälä, Näykki, Järvelä & Baker, 2017).

Motivation is constantly challenged during collaborative learning because motivation is connected to all the factors that make learning rewarding and interesting (Järvelä et al., 2010). Motivation has been defined as psychological drive which leads to cognitive engagement and ultimately achievement (Järvelä, et al., 2010). Thus, motivational challenges in collaborative learning may occur as challenges in students' productive participation and in different expectations, goals or priorities in group work (Järvelä et al., 2010; Barron, 2003). Motivational challenges may also have been caused by the too different backgrounds of the group members, interpersonal dynamics and some group member's off-task behavior (Rogat et al., 2013). One common challenge in group work is the so called "free rider effect", which means that some students may contribute less to the group work and rely on others finishing the task (Rogat et al., 2013). Motivational challenges may occur for example as challenges to maintain interest, lower level of participation, and commitment or different goals between group members (Näykki et al., 2014).

Social context plays a very important role in collaborative learning as social and cognitive factors of learning are intertwined in collaborative learning (Arvaja & Mäkitalo-Siegl, 2006). Despite that, the social interaction context is also demanding for learning because each learner is an active agent of their own cognitions and emotions (Järvelä et al., 2010). Social challenges can occur in collaborative learning for example as perceived incompatibility between group members, different working styles or communication styles, or power dynamics between group members (Arvaja et al., 2007). Prior research has also described socio-emotional challenges, where emotional regulation from individuals and from the group is needed (Järvelä & Järvenoja, 2009; Näykki et al., 2014). Tensions in learning may arise from different ways of working or communicating between learners, different levels of interest, from power dynamics between group members and different goals between group members. Working communication and mutual engagement in the work are essential for collaborative learning (Barron, 2003; Järvenoja & Järvelä, 2009).

Different practical hurdles may also disturb the engagement and participation for the group work, especially in social environments such as classrooms, where several groups and

people work at the same time. That may challenge the groups' emotions and motivations during learning (Järvelä & Järvenoja, 2009).

Challenges during collaborative learning seem to feed each other, meaning that for example if the student experiences a task as too demanding to be solved and has cognitive challenges, it can easily cause motivational challenges to try to solve the task (Koivuniemi et al., 2017). And if the group struggles with argumentation, it can easily influence the socio-emotional atmosphere in the group (Isohätälä et al, 2017). However, not all the challenges inhibit learning. Some challenges can even be productive and lead the group to find out even more new things if the group is capable to recognize and solve the problem (Zuiker, Anderson, Jordan, & Stewart, 2016).

#### **2.4 Regulation of learning: how groups adapt and coordinate their collaboration**

Collaborative learning is challenging for learners and demands engagement and coordinated communication from the group members (Barron, 2003). In other words, to be successful, collaborative learning must be regulated by learners (Hadwin, Järvelä, & Miller, 2011). Regulation of learning refers to activities where learners intentionally control their own learning process (Hadwin et al., 2011; Schoor, Narcisse & Körndle, 2015). According to Hadwin et al. (2011), challenge situations activate strategic regulation of learning. If groups can regulate their learning and overcome their challenges, their final learning results will be improved (Malmberg, Järvelä, Järvenoja & Panadero, 2015). Hadwin et al. (2011) present that a) regulation is always intentional and goal directed, b) learners regulate motivation, behavior and/or cognition and it is always embedded in social contexts and influences and c) research should target challenge episodes because they invite strategic regulation.

Socially Shared Regulation of learning (SSRL) is defined as group-level regulation, which happens in the context of collaborative learning (Panadero & Järvelä, 2015; Hadwin et al., 2011). It is understood as a situational reaction to the challenges that groups face during collaborative learning. Socially Shared Regulation of learning consists of cyclical phases of regulation which have first been presented as a part of the social cognitive model of Self-regulation (Zimmermann 1989; Hadwin et al, 2011). Those phases are 1) goal setting, 2) monitoring, and 3) evaluating learning process. In SSRL learners have a shared understanding of the task, such as shared goals, shared perceptions of the task or shared evaluation process, and therefore regulatory activities and strategies are shared and commonly decided (Panadero

& Järvelä, 2015). Perceptions of the group's challenges provide the target and the direction for regulating and adapting collaborative processes (Järvelä, Järvenoja, Malmberg, & Hadwin, 2013). Thereby different regulation strategies that group members or groups use are situation and context specific. The value of each strategy can be evaluated by how well it solves the faced challenge or fits to the situation at the time (Järvelä et al., 2013). The goal of SSRL is a co-constructed and a shared outcome of the process in which multiple individually-regulating individuals jointly construct and synthesize regulation strategies toward shared outcomes (Hadwin, et al., 2011).

Socially shared regulation of learning challenges learners. To be successful in collaborative learning, students need to be successful in coordinating their individual learning processes, acquire new understanding about the task, and to participate in the regulation of the activities of the group (Malmberg et al., 2015). Also, if the group's tasks are too easy, few challenges generally arise and regulation does not necessarily occur (Järvelä & Järvenoja, 2013). Thus, even though a shared knowledge construction and shared outcomes are the goals of collaborative learning and SSRL, they do not always imply shared regulation of learning (Järvelä & Järvenoja, 2013). SSRL occurs in interaction as a network of utterances rather than individual comments or actions (Järvelä & Järvenoja, 2013; Iiskala, Vauras & Lehtinen, 2004; Volet et al., 2009). It occurs in interaction when students externalize their metacognitive thinking, complement each other's utterances and commonly create a flow for comments (Iiskala et al., 2004). Volet et al. (2009) investigated high-level co-regulation which can be compared with SSRL (Panadero & Järvelä, 2015). According to their findings, four factors that maintained content processing, and therefore promoted high-level co-regulation as well, were question asking, tentativeness, background knowledge and shared positive emotions.

SSRL has been investigated a little bit over a decade (Panadero & Järvelä, 2015). Interest to investigate shared regulatory processes has emerged from changes in pedagogical practices in different learning environments (Panadero & Järvelä, 2015). Since previous research of collaborative learning has showed the effectiveness of it in promoting deep-level learning, and new information and communication technologies have changed the way how people communicate and collaborate, also new challenges have emerged in how groups coordinate their learning and engage in it (Panadero & Järvelä, 2015). The focus of self-regulated learning (SRL) field has shifted from investigating individual learning to investigate how groups regulate their work during collaborative learning and in computer supported collaborative learning (CSCL), but also for combining individual and group perspectives

(Panadero & Järvelä, 2015; Järvelä et al., 2010; Järvelä et al., 2015). Compared to other forms of regulation, research of SSRL has been quite minor and distributed (Panadero & Järvelä, 2015), but the amount of research concerning it is increasing. Understanding about regulatory processes in group learning is also connected with other fields of study, such as CSCL (Panadero & Järvelä, 2015). There has been empirical research that has showed evidence about existence of the phenomena in comparison to other forms of regulation (e.g. other regulation, co-regulation), research that has characterized the phenomena and research that has investigated how SSRL contribute students' performance (Panadero & Järvelä, 2015). There are several papers that have focused on researching SSRL from the aspect of regulating motivation, socio-emotional processes or metacognitive processes (e.g. Järvelä et al., 2010; Näykki et al., 2014; Iiskala et al., 2004).

Studies have been carried out to find out, how SSRL could be promoted better in collaborative learning. This is an important aspect in developing pedagogical practices. For example, the studies about promoting SSRL with scripts has been studied to find out, what kind of pedagogical design promotes social regulation on collaborative learning (Miller & Hadwin, 2015). Scripted discussions can be used to support collaborative learning and to foster regulatory interactions in different learning situations (Miller & Hadwin, 2015). Scripts can be understood as pedagogical methods, which facilitate the groups' collaborative learning by triggering specific interactions based on learning goals and design principles (Hämäläinen & Häkkinen, 2010). Scripts can support learning by guiding interaction at a detailed level (micro-scripts) or by setting up conditions for interaction at a broader level (macro-scripts) (Hämäläinen & Häkkinen, 2010). Macro-scripts facilitate collaborative learning by setting up conditions which enhance collaborative learning (Hämäläinen & Häkkinen, 2010; Näykki, et al., submitted). In other words, macro-level scripts enable students to figure out independently, which strategies and activities support their progress in solving a problem or a task. Miller & Hadwin (2015) describe, that when there is no script in collaborative learning, the students are less likely to start regulating their collaboration and rather skip planning or goal setting phase which leads to a weaker process of collaboration. Scripted interaction increases the students' awareness of challenges and can thus support the groups' success in collaborative learning (Näykki et al., 2017) When learners acknowledge and recognize their challenges, they may see a need to adapt their actions in collaboration to achieve better learning. Therefore, a perception of the groups' challenges creates a target and goals for socially shared regulation in group learning (Järvelä et al., 2013).

Different characteristics of interaction that are typical in successful collaborative learning have also been investigated to understand better the phenomenon of SSRL. For example, Isohätälä et al. (2017), investigated the relationship between emergence of SSRL and student's active participation in interaction in collaborative learning. They carried out a qualitative video data analysis, where they first analyzed the manifestation of SSRL and participation. In the second phase, they tested how the variation in student participation affected for SSRL. According to their results, SSRL involved more active participation than other in-task behavior in collaborative learning, and that SSRL occurred more prevalently if all students contributed to the discussion (Isohätälä, et al., 2017).

There has also been research about how phases of self-regulation change interaction during collaborative learning. For example, Sobocinski, Malmberg & Järvelä (2017) investigated how three phases of self-regulated learning occur in collaborative learning and compared occurrence of those three phases in high- and low-challenging collaborative learning sessions. They carried out a research, where video data was combined with log-in data from the application, which was supposed to increase awareness about cognitive, motivational and emotional challenges that group might face during their learning. According to their findings, in high-challenge sessions the groups switched more between forethought and performance phase, and that regulation phases and types of interaction that contribute to successful collaboration differed in low- and high challenge sessions. They also found, that regulated learning needs to be supported especially at the middle of the learning process (Sobocinski et al., 2017).

### **3 Aim and research questions**

Collaborative learning is an effective and motivating way to learn when it works (Rogat et al., 2013) and it is necessary for future teachers to experience, understand and implement collaborative learning to be able to use it in their pedagogy. To understand better how to support teacher students to develop their skills, it is important to define the current state of collaborative skills among teacher students (Häkkinen et al., 2016). This study focus on analyzing what kind of challenges teacher students face during their collaborative learning. The quality of challenges describe the state of students groups' learning skills. Similarly, challenges also play an important role in collaborative learning by activating students to regulate their learning and change their strategic activity (Hadwin et al., 2011: Häkkinen et al., 2016). This study gives examples about what kind of interaction those situations consists of, where SSRL occurs as situational reaction for faced challenges in collaborative learning. Thus, this study describes through seven examples, how the case group solve their challenges in collaborative learning and elaborates practical understanding about SSRL.

The research questions are:

- 1) What kind of challenges do the groups face in collaborative learning?
- 2) What is the amount of the experienced challenges in different groups?
- 3) How does a selected case group solve different types of challenges during the selected case example?

## **4 Method**

The method of this study is qualitative video data analysis and the goal is to explore collaborative learning in detail by analyzing interaction between the members of small groups (Chi, 1997). A two-phased analysis method was used to explore what kind of challenges the groups face during collaborative learning and to describe by way of illustration, how the group solves the challenges. In the first phase, the challenges were identified from the video data (20 hours) and after that one case session was chosen for further analysis. The groups' ways of solving their challenges was transcribed and explained to show examples about how the groups regulated their activities.

Data collection was carried out as part of the PREP21-project so this study focuses on data analysis. This study follows the same research setting as Näykki et al. (submitted) research about supporting socio-cognitive and socio-emotional monitoring with scripts that are created based on the theory of regulated learning (Näykki et al., submitted; Zimmermann, 2008)

### **Context and participants**

The participants of the research were first year teacher education students from a Finnish university. They were participating on a course about environmental science that lasted for five weeks (N=19, M<sub>age</sub>=23, 12 women). The students were working in groups of three to four students. Each group included both genders (Näykki, et al., submitted). The topics of the course were Species, Eco Systems, Maps, Planetary Phenomena, and Climate. The tasks of the course were technology enhanced, an open-ended task where students collaboratively designed methods on how the topic could be taught in primary school. The task was designed to enhance their pedagogical understanding of given concepts and phenomena in environmental science (Näykki et al., submitted). Computers, tablets and handouts were given for students for studying, documentation, sharing their tasks with other groups and searching for further information. The tasks required students to activate their prior knowledge, evaluate the relevance of different topics for primary school pupils and to negotiate their understanding of the subject (Näykki et al., submitted). During the 90-minute session, the groups had three macro-level scripted discussions where they were instructed to reflect on their thoughts and feelings, and to describe the strengths, weaknesses and



challenges of their work. The aim of the macro-level scripted discussions was to support groups' effective interaction and work during collaborative learning based on the three cyclical phases of regulated learning: 1) goal setting, 2) monitoring, and 3) evaluation (Näykki et al., submitted; Zimmermann, 2000). The scripted discussions were not analyzed in this study because they would have twisted the results since the students were guided to reflect on their challenges during the scripted conversations.

Data was recorded with cameras with spherical 360-degree point of view. The groups' discussions, gestures and moves were recorded. The students were working in a classroom kind of research space and all the five groups were working at the same time (Näykki et al., submitted).

#### **4.1 Identifying challenges from the data**

##### *Analysis procedures*

The analysis of the data was done by using QSR nVivo11 data analysis software. Five groups were recorded during five sessions (30 hours of videos), from which 20 sessions were chosen for the analysis of this thesis. The analysis focused on the interaction between group members, which means that only group level challenges were analyzed. The aim of the data analysis was to identify challenges that groups face during their collaborative learning sessions. Discussions between group members were observed from the videos. The participants' gestures and non-verbal expressions were not systematically analyzed, but they were in help to understand experienced challenges in group interaction.

The analysis was conducted at the group level and the aim was to identify through the group members' interaction the kinds of challenges the group faced in their collaborative learning. Therefore, the coding units were at the episodic level (Volet, et al., 2009). It means that the coded situations could consist of several turns and the length of an entry varied based on for how long the challenging situation continued in the groups' conversations.

- 1) The challenging situations were identified from the videos. The challenges were first identified by marking each moment during which the groups' collaboration was not progressing or they faced a challenge, meaning that something needed to be solved or something interrupted their work (e.g the group members did not agree about something, all group members did not participate in the conversation, something

external interrupted the group's work or they did not understand something). Social, emotional, motivational and cognitive factors of successful collaboration guided the identification of challenges in the data. Short explanations were written about situations.

- 2) The challenging situations were divided into four categories and 12 different subcategories based on the previous empirical research about the challenges in collaborative learning (Table 1) (i.e Näykki et al., 2014; Järvelä & Järvenoja, 2009).
- 3) All the videos were watched through again and the categories were reorganized.
- 4) The final categories of groups' challenges in collaborative learning were defined as challenges in understanding, challenges in interaction and organizing work, challenges in participation and external challenges.

Table1. Coding categories for challenges

<b>Main category</b>	<b>Subcategory</b>
<b>Challenges in understanding</b>	Challenges in knowledge construction
	Content knowledge
	Task understanding
<b>Challenges in participation</b>	Challenges to maintain interest
	Participants are tired
<b>Challenges in interaction and organizing work</b>	Different working styles
	Challenges in communication
	Division of work
<b>External challenges</b>	Challenges in time management
	Devices do not work
	Skills to use ICT tools are insufficient
	External interruption

The challenges in understanding refer to challenges in cognitive processes, such as challenges in knowledge construction and content understanding (Van den Bossche et al., 2006). The challenges were divided into subcategories of challenges in knowledge construction, task understanding and content understanding. Challenges in participation refer to the motivational challenges in the groups' work (Järvelä et al., 2010). The level of student

participation was understood an indicator of student motivation, because it could be easily analyzed from the video data. It included subcategories called challenges to maintain interest and tiredness of students. Challenges in interaction and organizing work refer to social challenges, such as challenges in interaction and communication in the group's work (Arvaja et al., 2007). This category also included situations, where the socio-emotional atmosphere in a group was challenged for some reason. Subcategories were challenges in interaction, challenges in communication, challenges in management of time and different working styles. External challenges refer to practical hurdles (Järvelä & Järvenoja, 2009) which were caused by something else than the group members or their actions in the learning. These involved for instance technical problems, the other groups interrupting the group's work or lack of skills using digital tools. The subcategories were external interruption, devices do not work and skills to use ICT are insufficient.

#### **4.2 Case example of group solving their challenges**

The second part of the analysis was conducted to provide a descriptive example about how the case group solve their challenges during the collaborative learning session. The theoretical basis of the case analysis was aiming to define those characteristics of socially shared regulation (SSRL) in the group's interaction, which could be found from the case session. At first, two cases from the data were chosen for the further analysis, based on the amount of challenges found in the first phase of the analysis. After that, both videos and explanations of the situations were reviewed. Session 2 from the group E was chosen as the case example because the group had high amount of challenges, and several challenges in their understanding and collaboration, but only one challenge in participation. According to Isohäätä et al. (2017) the probability of SSRL manifesting in group interaction is higher when all students participate equally in their group work. Because the challenges in collaborative learning invite regulation (Hadwin et al., 2011), all the previously coded situations with challenges and group's ways to solve them were transcribed from the case session. After that, seven situations were chosen as examples to describe how the SSRL occurs in group interaction and how the case group solve their challenges.

The example situations describe following characteristics of SSRL:

- 1) Regulation manifests with a question or explanatory statement (Volet et al., 2009).

- 2) Group members support each other's to maintain their motivation. (Järvelä et al., 2010)
- 3) Group members give emotional support to each other's and maintain positive atmosphere. (Järvelä & Järvenoja, 2009)
- 4) Students externalize their metacognitive thinking (Iiskala et al., 2004)
- 5) Challenge-awareness in the group helps group to find solutions for their challenges (Näykki et al., submitted).
- 6) SSRL is an adaptive mental process which is negotiated and fine-tuned in collaboration (Isohätälä et al., 2017).
- 7) In real-life collaborative setting, students must regulate many challenges similarly (Hadwin et al., 2011).

## 5 Results

### 5.1 What kind of challenges groups face in collaborative learning?

First phase of the analysis focused on identification of different challenges in groups' collaboration. All groups faced challenges during all of the collaborative learning sessions. Challenges were divided on four main categories and examples about each category and subcategory are presented in the appendix 1. Amounts of challenges during the analyzed sessions are presented in the appendix 2. Table 2 presents the amounts of challenges in each subcategory. Those amounts are used in this chapter to explain how common different challenges were.

Table 2. Challenge amounts in each subcategory

<b>Main category</b>	<b>Subcategory</b>	<b>Amount of challenges in the whole data</b>
<b>Challenges in understanding</b>	Challenges in knowledge construction	28
	Content knowledge	57
	Task understanding	19
<b>Challenges in participation</b>	Challenges to maintain interest	35
	Participants are tired	9
<b>Challenges in interaction and organizing work</b>	Different working styles	9
	Challenges in communication	17
	Division of work	17
<b>External challenges</b>	Challenges in time management	11
	Devices do not work	30
	Skills to use ICT tools are insufficient	15
	External interruption	30

The most common challenges in the data were challenges in content knowledge, maintaining interest, devices that did not work and external interruptions (Table 2). Groups also faced challenges in interaction and organizing work when their communication was not sufficient, or division of work was challenging between group members. External challenges were mostly connected to ICT tools that didn't work or they were not familiar for students.

#### *Challenges in understanding*

Groups had relatively lots of challenges in understanding. Challenges in content knowledge were the most common challenges in the data ( $f=57$ ) and they occurred in all sessions of all the groups (appendix 2). Challenges in content knowledge appeared when students didn't or they could not activate their previous knowledge about the environmental phenomena or about primary school aged children, they remembered things in a wrong way which caused confusion or they had challenges to understand the content.

Challenges in task understanding were challenges, where students of the group understood the given instructions in different ways, they didn't understand what they were supposed to do or they passed some instructions. Task understanding included challenges to understand of why something was asked to be done (for example why groups had to do scripted discussions or what is the purpose of goal setting in the task). Challenges in task understanding ( $f=19$ ) were not as common as challenges in content knowledge, but they still appeared in 14 sessions from 20 (appendix 2).

Challenges in knowledge construction appeared when group members disagreed about how things were supposed to be presented or organized in their task or they understood the content in different ways. It also appeared when group struggled to find common solution for their differing perspectives and argumentation of different perspectives challenged the group atmosphere. Challenges in knowledge construction were quite common ( $f=29$ ) and appeared in 13 sessions from 20 (appendix 2).

#### *Challenges in interaction and organizing work*

In the category of challenges in interaction and organizing work, challenges in communication were as common as division of work ( $f=17$ ). Challenges in management of time and different working styles were not so common ( $f=11$ ). Challenges in communication occurred, when group members misunderstood each other, they didn't understand what other

group member said, or they didn't listen what someone else said. At some cases, the way how students expressed themselves caused a challenge in group atmosphere by being overruling or unfriendly. Challenges in communication occurred in 11 sessions from 20 (appendix 2).

Challenges in division of work (f=17) occurred in situations where some students in the group didn't know what to do, some group members did everything alone, decision-making in the group was not equal or some group members were not aware of the division of work negotiated in the group. Challenges in division of work occurred in 8 sessions from 20 (appendix 2). In this category, other groups had 1-3 challenges in division of work, but one group had specifically many challenges in this category.

Different working styles occurred when groups had challenges to find common ways to proceed in their work or they had too dissimilar working styles. For example, when one of the group members was interested to do the task carefully and wanted to put an effort for it to learn, others were more interested to get the task done and continue. These students had chosen different strategies for learning which caused a challenge between group members' different working styles. Different working styles occurred in 7 sessions from 20.

Groups challenges in managing time occurred in 14 sessions from 20. Most often the challenges in this category included situations where group had to hurry to finish their task because they didn't follow the time during the session.

#### *Challenges in participation*

Challenges in participation included challenges in groups' capability to maintain their interest toward task and situations, were students were tired or they announced their tiredness themselves. Challenges in maintaining interest (f= 35) occurred in 13 sessions from 20 (appendix 2) and it was the second most common challenge of the data. Challenges to maintain interest occurred when group started a conversation about something else, one of the group members didn't participate in joint work but rather stayed silent or did something with his/her smartphone. Student tiredness (f= 9) did not occur so often in the videos, only 6 videos from 20 (appendix 2).

#### *External challenges*

Groups had challenges with devices and with the use of ICT tools during 19 sessions of 20 (Appendix 2). Either challenges were caused by device which did not work (f= 30) or students did not know how to use ICT tools needed in solving the task (f=15). The challenges

with devices were most often caused by tablets where the keyboard connection didn't work so well. When students decided to change for laptops, they had to wait few minutes that old laptops were ready to be used. Sometimes internet connection did not work. When students did not know how to use ICT tools, it was most often because students did not know how to use Google drive, which was used in the course for sharing materials and for commenting other groups work. Students struggled also with using tablets. Lack of skills using ICT tools occurred in 11 sessions from 20 and devices did not work in 16 from 20 sessions (appendix 2).

External challenges (f= 29) occurred when other groups interrupted groups work, someone left in the middle of the session, mics of students' dropped or anything practical hurdle interrupted their work. External challenges occurred in 14 sessions from 20.

## 5.2 What is the amount of challenges in different groups?

This chapter presents challenge amounts of different groups. First, challenge amounts in different sessions are compared. After that the challenge amounts and types in different groups are presented. In the end of the chapter, it is explored which categories occurred often simultaneously in the sessions. Total amount of challenges during each session is presented in table 3.

The biggest amount of challenges during one session was 24 and the lowest amount was 7 (table 3). The highest challenge amounts were experienced during the session 2 and 3 (table3). Threshold values are defined to describe the variation of challenge amounts of the sessions between different groups (Table 4). The values were defined based on the total amounts of challenges in the sessions (appendix 2).

Table 3. Amount of challenges in analyzed sessions.

Group	session 1	session 2	session 3	session 4	session 5
GROUP A	10	11	8	-	-
GROUP B	8	16	23	7	16
GROUP C	-	17	10	15	19
GROUP D	10	19	22	10	7
GROUP E	-	23	13	-	12

- = missing data



Table 4. Threshold values of challenges in different challenge categories.

<b>Challenge category</b>	<b>Variation of challenge amounts in different categories</b>	<b>Threshold value for high amount of challenges</b>
Challenges understanding	in 2-11	$\geq 6$
Challenges participation	in 0-7	$\geq 4$
Challenges interaction and organizing work	in 1-10	$\geq 5$
External challenges	0-8	$\geq 4$

Table 5 describes the average amount of challenges which groups had in their sessions. It also describes the variation between the lowest and highest challenge amounts of different groups (R). Averages between the groups varied from 9,6 (group A) to 16,0 (group E) challenges. Group E and group C had the highest averages in challenge amounts. Range of the challenge amounts varied between the groups. Group B and Group D had the highest ranges in challenge amounts between sessions.

Table 5. Averages of challenge amounts in analyzed sessions of the groups and the range (R) of challenge amounts.

<b>GROUP</b>	<b>Number of analysed sessions</b>	<b>Average of challenges of the group</b>	<b>Range (min, max),</b>	<b>R</b>
<b>A</b>	3	9,6	(8,11)	3
<b>B</b>	5	14,0	(7,23)	16
<b>C</b>	4	15,3	(10,19)	9
<b>D</b>	5	13,6	(7,22)	15
<b>E</b>	3	16,0	(12,23)	11

#### *Group A*

Three sessions from group A were analyzed in this study. During their collaborative learning session, group A had the lowest average amount of challenges from all the groups (table 5). Variation of the amount of challenges was small between different sessions (R=3) (table 5). During their first session, group had mostly challenges in their interaction and

organizing work ( $f=6$ ), but during the other two sessions, they had mostly challenges in understanding ( $f=4$ ) (appendix 2). This group had least challenges in the data.

#### *Group B*

Five sessions from the group B were analyzed in this study. During the five weeks course, the amount of challenges varied a lot in the group ( $R=16$ ) (table 5). During their session 4, group B faced only 7 challenges but during the session 3, they faced 23 challenges which is the highest amount of challenges from all the sessions in the data (table2). They also had sessions where none of the challenge categories riced above the threshold value (appendix 2). Average of challenge amounts in group B was 14, which is third highest average in the data (table 5). During the session 3, group B had high amount of challenges in all the main categories, except in challenges in understanding where they had 5 challenges (appendix 2). Group B had high amount of challenges in interaction and organizing work in 3 from 5 sessions. The group had relatively lots of challenges in understanding during all the sessions, but they did not always exceed the threshold value.

#### *Group C*

Four sessions from the group C were analyzed in this study. The amount of challenges in group C varied from 10 to 19 challenges ( $R=9$ ) (table 5). From all the groups, group C had the highest average of challenges which was 15,3 (table 5). During the session 5, group C had 19 challenges from which challenges in understanding ( $f=7$ ) and external challenges ( $f=9$ ) were over the threshold value. During 3 sessions of 4, group C had challenges in participation and in none of the sessions group had high value of challenges in interaction and organizing work.

#### *Group D*

Five sessions from the group D was analyzed in this study. The amount of challenges in group D varied quite a lot between the sessions ( $R=15$ ). The lowest amount of challenges in group D was 7 (session 5) and highest 22 (session 3) and the average amount of challenges was 13,6 (table 5). Group D did not have high amount of challenges in any category during their first and last session, but during third session, they had high amount of challenges in three categories (challenges in understanding 8, challenges in interaction and organizing work 5 and challenges in participation 5) (appendix 2).

### *Group E*

Three sessions from the group E were analyzed in this study. The amount of challenges between sessions varied from 12 to 23 (R=11) (Table 5). The average amount of challenges in group E was 16,0, which is the highest average in the data (table 5). During the session 2, group E had high amount of challenges in interaction and organizing work (f=8) and challenges in understanding (f=11). Group did not have so much challenges in participation.

### *Challenge combinations in the groups*

From different challenge types, high values of challenges in understanding and challenges in interaction and organizing work occurred most often together (Appendix 2). 4 sessions included high amount of challenges in both of these main categories. Group A and group E had high or middle amount of challenges in these categories, but similarly they did not have challenges, or they had a minimum amount of challenges in categories of external challenges and challenges in participation. Besides that, high amount of external challenges and challenges in participation occurred similarly in four sessions. Group C had high amount of challenges in these categories during all their sessions, but they didn't always occur similarly.

## **5.3 How does the selected case group solve different types of challenges during the selected case example?**

The selected case group was group E, who had 23 challenges during their 73 minutes long session 2. This session was chosen as case example because the high amount of challenges in their work. Another reason for choosing the example, was the quality of challenges. Group had overall 8 challenges in interaction and organizing their work, and 11 challenges in understanding, but they had only one challenge in participation. Socially shared regulation of learning manifests most prevalently when all students contribute for the discussion and when students respond and adapt to each other's contributions (Volet et al., 2009; Isohäätä., 2017). Based on the preliminary analysis, it was known that group used time for negotiating different perspectives, and everybody in the group were participating actively for collaboration during the session. These observations support the idea, that the group was engaged in solving their collaborative task and constructing knowledge together.

This case example focus on describing how group solves their challenges during collaborative learning session, and what kind of characteristics of SSRL could be found from the interaction in transcribed situations. Based on the previous literature and what was found from the case session, following characteristics were chosen to be described in example situations:

*1) Regulation manifests with a question or explanatory statement*

In this case example, group had challenges in interaction and content understanding. During the session, group had challenges to define, which information belongs to core content and which to complementary content. Before this situation, Janina asks if everybody agrees about living and non-living belonging to ecosystem. After everyone has agreed with Janina, Timo presents a question which is followed with intensive discussion between Janina and Sanni, who argument their differing perspectives about the topic.

00:17:57-00:19:41

**Timo:** Is it core content, that ecosystem always has producers, consumers and decomposers?

**Others:** yes.

**Minna:** So how do I write it here?

**Sanni:** Write that ecosystem includes producers, consumers and decomposers. And you can put in brackets what they mean and..

**Janina:** But is it necessarily like that? I just wonder if it goes over the core content then.

**Sanni:** Well I think it's core content.

**Janina:** Yes, but if you think that there are pupils who have lots of difficulties to learn, then I think that core content should be like we spoke on the lecture on the other day, that it is something very simple like:” Sun is a big star”. And the core content is something that everybody should learn then.

**Sanni:** Okay but if you think that it is still:” the core content to teach in your opinion” and ecosystem consists about them...

**Janina:** That's true.

**Sanni:** ... so no matter how much you want to differentiate teaching, I still think that it is the basic knowledge because it is also needed to understand further things in the future.

**Minna:** Maybe complementary content then is that what producers, consumers and decomposers are?

**Janina:** Yes, that is what I meant, that they belong to core content, but if you start defining them, it's different.

**Minna:** Then it is maybe complementary knowledge is we start to view the concepts.

**Sanni:** Oh, I would still put them to the core content.

During the situation, Janina also maintains positive atmosphere by echoing Sanni's arguments before telling how she thinks. As described in Isohätälä et al (submitted), intensive argumentation may arise socio-emotional challenges in group interaction. During this situation socio-emotional atmosphere in the group is challenged when Janina and Sanni explain their aspects about the core content. Sanni speaks with edged tone. Minna tries to push conversation towards finding a solution for the challenge. When it seems that Sanni and Janina disagree about core content too badly, Minna tries to push the solution by asking what Timo thinks about the core content, and similarly helps Timo to participate in intensive conversation. Timo's answer support both Janina's and Sanni's arguments, which helps group to maintain positive atmosphere.

00:20:30- 00:21:53

**Minna:** What do you think, Timo? This is a bit two-sided case.

**Timo:** Yes, it is just when you don't know what should be included in the core content...

**Janina:** Yes and because it depends of the grade.

**Sanni:** Exactly, but then if I think about a four grader, I think there already has to be that...

**Minna:** That's true.

**Sanni:** Because then I think that differentiating teaching means that those contents are not just studies in so detailed level, but narrower.

**Timo:** Maybe we could then just add short description in brackets for the core content.

**Sanni:** Yes, that's what I suggested that put descriptions in brackets.

**Timo:** But not like too specific description.

**Sanni:** Yes, of course not.

**Minna:** The complementary content could then include specific descriptions

2) *Group members support each other's to maintain their motivation*

In this case example, group has the challenge in participation. Sanni starts to wonder about the classroom and addresses her interest to something else than to the task. Tomi responds for her shortly, but others don't react for her questions, they just continue working. While one of the group members tries to start a conversation something irrelevant, others regulate that behavior by ignoring the comments which stops the irrelevant conversation quickly.

00:12:25-12:47

**Serafina:** So is this classroom used for something else as well? Or is it just for research purposes?

**Tomi:** I don't know if this is used for something else.

**Maarit:** (*working with computer*) should I just go to internet with this?

**Serafina:** It is quite cool tough.

**Maarit:** How should I log in to google?

3) *Group members give emotional support to each other's and maintain positive atmosphere*

In this this case example group has challenges in interaction. Sanni proposes that they could add something about photosynthesis for the task, but starts to doubt her ideas. Because of the previous discussions, she had to adapt her ideas to what others thought and sounds edged. When other group members do not react immediately for what Sanni says, Timo supports her idea and responds with encouraging voice. Because of the positive reaction, Sanni continues by asking if others know when photosynthesis is taught at schools. When Minna and Sanni don't react to her questions, she becomes a bit frustrated and then Janina responds to her why they don't necessarily need it there. Sanni starts to look for more information about the topic from the book.

00:23:29-00:24:10

**Sanni:** Should we add that only plants can make photosynthesis? Or only green things. Well, what ever... We don't have to.

**Timo:** Well it is quite closely related to it.

**Sanni:** Yes, it just depends if they already have studied what is photosynthesis. When is it studied at school? Do they know it? Well don't put it there, let's go forward so we don't have to stick to this.

**Janina:** But, mm... We have to keep in mind that the topic is specifically the forest ecosystem. We have to bring there the aspect that it is not all the ecosystems, but specifically forest ecosystem.

**Others:** That's true

**Sanni:** Where do we have the book of fifth grade, may I also have a look at it?

**Janina:** Sure, there wasn't anything tough.

#### *4) Students externalize their metacognitive thinking*

In this case example, group has challenges in knowledge construction. During the situation, Minna asks what she should add next and suggests something. Then Janina answers for her, but starts then to doubt her thoughts. She starts to describe what she experiences like their challenge in the task and Minna continues her thought about that. They elaborate the challenge and about that together.

00:44:04-00:46:12

**Minna:** Should I add the special knowledge here then? Now we have food chain and food web here?

**Janina:** Add key species and then... Should we add the diversity? I feel that all this information is important because they are somehow clear to ourselves and then it's really hard to define what is the core content.

**Minna:** Exactly, what is the previous knowledge of the children?

**Janina:** Yes, and what is the limit kind of, how do you define what is complementary and what is special knowledge?

**Minna:** Exactly. This is the first time for us when we have to think what is the core content and what is complementary. We haven't gone through these kind of things before.

**Janina:** Yes and even though you wouldn't remember it all so well, it is all something we have studied ourselves. And when we have all the 12 years of experience from school and all the knowledge in the background. Fourth graders have only three years of experience from school.

As a second example about externalizing metacognitive thinking, there was a situation where group had challenges in content knowledge, knowledge construction and in interaction. After the challenge situation, Janina externalizes her notion about Sanni's frustration after the

previous conversation and facilitates positive atmosphere in the group by explaining that the group's perception about the core content is still unclear because they didn't have the lecture about it yet and by echoing Sanni's previous arguments about fourth graders.

00:21:50-00:22:29

**Janina:** It's a bit pity that we haven't had yet the lecture about core content.

**Sanni:** m-mm. Yes.

**Janina:** Because like.. I think it's kind of true what you said that they are already four graders that...

*5) Challenge-awareness in the group helps group to find solutions for their challenges*

In this case example, group has challenges in task understanding. During the conversation, group members makes their challenges visible by explaining why they feel goal setting being so difficult. When students elaborate their understanding about the challenge and become better aware of that, they have better chances to solve their challenge as well. Sanni presents a question about how goal setting is asked to do which helps group to direct the conversation towards the solution in goal setting.

00:48:14-00:49:11

**Janina:** It's very hard to set these goals if you start to think about them carefully and not just put something general.

**Satu:** Do they want these to be some spesific goals or can they be more general?

**Janina:** Well yes they can be general, but then we have to have some task where you can practice the goal.

**Satu:** ah yes..

**Timo:** Yes. But it is always like this to set goals.. It is kind of important even though they are often so general like in curriculum as well.

**Minna:** Yes, they are so impresice.

**Timo:** I think it is often like... It's very simple thing which already makes you to achieve the goal

**Satu:** Yes, something simple

*6) SSRL is an adaptive mental process which is negotiated and fine-tuned in collaboration*



In this case example, group has challenges in interaction and knowledge construction. This situation is from the end of the session, where group evaluates the plan of the other group. During this situation, group sums up what they have been discussing during their collaborative learning session. This example describes how both Janina and Sanni have found some kind of common understanding about the topic and they make visible that they have adapted their thinking to support and understand each other's aspects about. During the conversation, Sanni describes to others how does she understand the topic and in that way helps others to understand her point of view. The challenge in this situation is that Sanni understands first wrong the size of the core content in other group's work, which leads for the interesting discussion where students continue the formulation of shared understanding.

01:03:53-01:05:17

**Janina:** I think this is quite broad as core content

**Minna:** Yes

**Janina:** Of course those are important things, I understand, but if you think about it, it's really broad...

**Sanni:** Well I don't know, it's a fact that you have to base these things for children.

**Janina:** Yes

**Sanni:** But from this I understand immediately that, okay a rabbit is a specimen, then there is a population, animal community and ecosystem.

**Janina:** Sure, I understand that these things are important and in my opinion too, and these are exactly those things that you should learn during primary school.

**Sanni:** Okay, but is it then...

**Janina:** But if you have a fourth grade with pupils in all different levels and they all should learn something from there, then the core content should be what everybody learn.

**Minna:** Yes, something simple and the main thing.

**Sanni:** That's true.

**Minna:** I think the main thing here is ecosystem itself and all these other concepts and the rest is the content that complements it.

**Sanni:** Yes, right.

**Janina:** But then on the other hand, what you said about that to understand ecosystem, you have to understand all the other concepts as well.

**Minna:** Yes.

**Janina:** But it's a pity that we haven't had the core content lecture because of this, how do we define it.

**Sanni:** How do we know how to evaluate this?

**Janina:** But what is then for complementary knowledge?

**Sanni:** What is there? The concepts of ecosystem more precisely, right?

**Janina:** Yes, well this is all the core content

**Sanni:** all of this?

**Janina:** yes.

**Sanni:** Aa-a (surprized)

**Janina:** Yes, that's what I ment, it's very broad.

**Sanni:** Ahaa, so it's all that. I thought it wasn't like that... Now I see.

*7) In real life collaborative learning setting, students have to regulate many challenges similarly*

In this case example, group has challenges with devices which do not work and with interaction. The situation is from the beginning of the session, where group has just started working and they are still settling down. They try to figure out how the keyboard works, discuss about using Gmail or some other email service and organizing their work so that each group member is able to participate in their work.

00:09:22-00:11:25

**Minna:** Does anyone have Gmail?

**Janina:** Yes... But do we need a laptop or can we do the task with that (tablet)?

**Minna:** We can do with this if we have the username.

**Sanni:** Can't we do it to our own email? Isn't it possible there as well? Should we ask?

**Janina:** Well, we have Google drive here, I can log in.

**Sanni:** okay, you have the username.

**Janina:** Yes. How do I turn this on, is it on already the...?

**Minna:** keyboard?

**Janina:** Yes, it would be much easier to write.

**Minna:** Now it is.

**Janina:** It didn't work last time. I don't know if it works. I don't feel like writing with the tablet. Should we take a laptop? This doesn't work.

**Timo:** They told us last time that too many people use the keyboard here.

**Janina:** Yes, well I can write directly to tablet as well.

**Sanni:** But we don't see now what you're writing. Well, maybe we don't need to see what she does...?

**Janina:** I can turn this.

**Minna:** She just logs in there.

**Janina:** we could take the laptop as well. Should we take a laptop? Would it be easier to work with that? Does takes too much time if I start to pick letters?

**Timo:** I guess we can take the laptop.

**Sanni:** We could take the laptop, there are still some of them free.

**Minna:** *(for the teacher)* We can take the laptop. It is so slow to work with this.

**Janina:** It (tablet) doesn't work when there is so many of these that it doesn't recognize this.

**Minna:** *(gets the laptop from Sanni)* This is giant.

**Sanni:** Do you need the charger for it?

**Minna:** I can write. I just don't have the username.

**Janina:** Yes, I can log in.

As a summary, the most common challenges were challenges in content understanding, challenges to maintain interest, external challenges and challenges with devices which did not work. Challenges were found in all categories. Challenge amounts in the groups were presented through average of challenge amounts and range, and finally the quality of the typical challenges for each group was shortly described. Group A had least challenges and least variation in their sessions. Group B had the biggest variation in challenge amounts between sessions, their average was relatively high and most common challenge type for the group were challenges in interaction and organizing work and challenges in understanding. Group C had the highest average of challenges, but the range was not so big. The most common challenge type in this group was external challenges and challenges in participation. Group D had relatively low average, but they had big range in their challenge amounts. The most common challenge types in the group were external challenges and challenges in understanding. Group E had the highest average of challenges in the data, and the range was mean. The most common challenge types in the group were challenges in understanding and challenges in interaction and organizing work.

The case group had overall 23 challenges from which eight situations were chosen as case examples to describe how the group solved their challenges and how does the SSRL occurs in interaction. The case examples were chosen based on the seven characteristics that were found to describe SSRL in previous literature. Group managed to solve their challenges and construct shared understanding about the task. The ways how groups regulated their learning during the session, were described as helping other group members to maintain positive atmosphere and motivation, as group members adapting and negotiating their thoughts towards shared solution, how SSRL occurs with an explanatory statement or a question, how challenge awareness helps the group to solve their challenges and how students must regulate several challenges similarly.

## 6 Discussion

The aim of this study was to analyze, what kind of challenges small groups of teacher students experience during collaborative learning sessions, how much different groups had challenges and describe through case example, how groups solve different challenges and thus describe in examples how the group regulated their learning. According to the results, groups faced most often challenges in content understanding and in maintain of interest, but also different external challenges were common. Groups experienced from 7 to 23 challenges during one session. Challenges amounts varied a lot in two of the groups between sessions and in two of the groups challenge amounts were some more stable. The case examples described how SSRL occurs in interaction and presented seven different ways of how the group solves their challenges.

This thesis is in line with previous research about the types of challenges referring to cognitive, motivational, social, socio-emotional challenges and practical hurdles in collaborative learning (Van den Bossche et al., 2006; Järvelä et al., 2010; Arvaja et al., 2007; Näykki et al., 2014). Challenges occurred in all the main categories. In collaborative learning, the central mechanism for learning is knowledge construction to what students are engaged in (Arvaja et al., 2007). In ideal situation, challenges arise when something inhibits group to engage in knowledge construction and activates the reactions in learners to maintain their interest, positive atmosphere and knowledge construction in the group. If group members are not motivated or they have other problems such as they are tired already when the task begins, it can be hard to push the group to engage well in knowledge construction and problem solving processes.

It is described in previous research, that ill-structured and challenging tasks are important in collaborative learning to activate the use of strategic learning skills (O'Donnell & Hmelo-Silver, 2013; Dillenbourg, 1999), but the practical problem is to set up such conditions for each learner and each group, with matching challenges. Challenges are understood as important mechanisms to activate regulation (Hadwin et al., 2011), but it does not mean that all kinds of challenges help groups to learn. Even though group would solve all the challenges that they experience, it does not always lead for engaged problem solving and knowledge construction processes. Järvelä et al. (2013) suggest in their study about challenges in groups collaborative work and SSRL, the degree of collaborative success may

be related to the type of regulation that develops over time when collaborative success.

In this study, groups were studying in open learning space with other groups, and technology was used as a tool, so external interruptions were common. If group was not able to solve their external challenges quickly and/or there were many external challenges, the time that could have been used for learning shortened significantly. Besides that, it took some time from students to get back on where they were with their work before interruption, and therefore it could affect for the quality of their outcome as well. For future research, it could be useful to identify more precisely, what kind of challenges especially activate regulation and strategic coordination of learning and how they are connected to the level of students' learning skills.

The group who had high amount of challenges in understanding, was probably more focused on solving the task than the group who struggled with external challenges and participation. Challenges in understanding included situations, where challenges were rather pushing group towards better learning outcomes than interrupting learning. Especially the situations, where students disagreed about something and they had to argument carefully their opinions, often revealed some gaps in their knowledge. This kind of challenges are described as cognitive conflicts in previous literature and they are understood as important mechanism promoting learning in social learning settings (Arvaja & Mäkitalo-Siegl, 2006).

Koivuniemi et al. (2017) describe the comorbidity of challenges. It means that one challenge causes another one. In this study, the category of challenges in interaction and organizing work included challenges which were followed by some other challenges such as challenges in knowledge construction, and challenges that then resulted more challenges in group's work later during the session such as challenges in division of work. The idea of comorbidity highlights the need for group regulating their work and to react for the faced challenges during the learning session, to prevent occurrence of possible further challenges as well.

In this study, the situational nature of learning came out in several settings. The variation of challenge amounts described how many factors may affect for successful learning session. Group B and group D presented good example about variation in challenge amounts when they in lowest had under 10 challenges and at highest over 20 challenges. When these groups had challenges, they occurred in several categories. Students' abilities to participate, engage and contribute the common learning process varied based on different situational factors such as tiredness. On the other hand, some characteristics in groups' work were more

stable, as group A managed to keep their challenge level low during all the analyzed sessions and as group B had upraised amount of challenges in participation and external challenges during most of the sessions.

The case group had several challenges during the case session, but they could overcome them. Thus, it can be assumed that their learning result was improved during the session (Malmberg et al., 2015). Through the examples of the session, it could be seen how the group members adapted their thinking and developed their ideas towards shared understanding about the topic. This study presented examples about how SSRL occurs in interaction. The field of SSRL is still emerging and there has been research about it a little bit over a decade (Panadero & Järvelä, 2015). There is not so much practical understanding about SSRL among educators. For future development, not only experiences of teacher students about collaborative learning are needed to increase, but to change the pedagogical culture, they also need more pedagogical understanding about the processes that have central role in collaborative learning.

Video data analysis is an iterative process that involves cycles between the video records, evolving hypotheses and data interpretations (Barron et al., 2013). Thus, author's experience in analyzing video data have an effect for the results of the analyses. Video recordings include big amount of different kind of data about interaction processes between group members. Experience about analyzing video data help researcher to recognize different factors in interaction and therefore improve the results and reliability of analysis. The precision of marking the challenge situations could have been better defined to get more reliable results from the analysis. Conducted research was ethically considered. Permissions were asked from all the students that participated in the research. The names of participants were changed in transcribed examples and video data was carefully stored during the research process that it could not end up for other purposes than for research.

The conditions for collaborative learning were good in the collected data. The tasks were carefully designed and scripted discussions were supporting students' challenge awareness and promoting their regulation of learning (Näykki et al., submitted). The chances of learners to recognize their challenges during the collaborative session were higher and groups possibly solved some of the challenges during the scripted discussions. In real life educational settings, the level of support and careful design of collaborative tasks vary much more. Previous research has pointed out that especially in minimally guided learning

environments, students do not necessarily achieve learning with high-level collaboration and understanding (Kirschner, Sweller & Clark, 2006). For developing the pedagogical culture at schools, it would be important to know what kind of challenges students experience in those settings where they study collaborative learning in their everyday life. Volet et al. (2009) suggest that bad experiences about collaborative learning decrease the level of engagement also in future collaborative learning situations. Therefore, it would be especially important for students future collaborative learning experiences to produce more practical information for teachers about what kind of challenges students have and how collaborative learning can be supported with design and instruction. Besides the good conditions in this study, students already had at least 12 years of experience from studying in different levels of education. When collaborative learning is implemented in primary school, the developmental level of children, as well as academic and social skills of small students must be considered carefully in designing collaborative learning.



## 7 Conclusions

This study presented an overall picture about the challenge types and amounts of situations in the small groups of teacher students during five week's course and examples about how the case group regulated their learning. This study increases the understanding about what kind of challenges teacher students have in collaborative learning. The role of challenges that referred to cognitive processes, challenges in participation and external challenges rose important in the results. Based on the analysis, it seems that although students have high amount of challenges during the session, they can be able to solve them and focus on knowledge construction, but depending on the group's skills to coordinate their learning, they do not always solve their challenges and might have similar challenges during several sessions.

Common-level understanding about what kind of challenges groups can experience during collaborative learning is important in developing pedagogical practices in teacher education. Teachers need also more understanding about how collaborative learning can be supported and how students regulate their learning to implement high-quality collaborative learning as future teachers. Research about teacher students' challenges produce valuable information about how teacher students could be supported even better in acquiring collaborative learning in the future. To address students' focus on the right place in collaborative learning, student groups could be supported especially in controlling external challenges and challenges in participation.

SSRL is a complex phenomenon which has not been research for so long time yet. Practical examples about regulation of learning helps teachers to understand and recognize the important characteristics of social interaction. There is a general claim, that one of the biggest challenges in the field of education is the need for better dialogue between science and pedagogical practices. Collaborative learning has been researched for over twenty years (i.e Roschelle & Teasley, 1995; Dillenbourg, 1996), but implementation of collaborative learning methods in educational field seems to happen very slowly, as many pedagogical institutions still educate their students in very traditional ways (Häkkinen et al., 2016). Besides teacher students need positive experiences about collaborative learning, more practical understanding about socially shared regulation and different ways to support collaborative learning with scripts, task design and with teacher's support, is needed in teacher education.

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## Appendix 1

### Appendix 1. Data examples of challenge categories

Category	Definition	Qualitative example from the data
<b>Challenges in understanding</b>		
Challenges in knowledge construction	Students understand the topic in different ways, they have different perspectives for the phenomena or they struggle to negotiate a common solution for their perspectives.	<p><b>Lauri:</b> On the other hand we could draw a line straight from goals to contents, because we know directly which goal is connected to which content.</p> <p><b>Kaisla:</b> Yes, and it is connected for all of those.</p> <p><b>Lauri:</b> yes.</p> <p><b>Kaisla:</b> Well how is it done?</p> <p><b>Isa:</b> You have to move that and.. Exactly, and then we draw some kinds of lines from there..</p> <p><b>Matti:</b> Goals. From goals to contents?</p> <p><b>Kaisla:</b> How did you thought this Lauri?</p> <p><b>Isa:</b> You could just draw the line from goals to contents?</p> <p><b>Kaisla:</b> Yes there. But don't they become too long?</p> <p><b>Kaisla:</b> (<i>looks at Lauri</i>) is it..?</p> <p><b>Lauri:</b> I can't see it, but I'm sure it's good enough.</p> <p><b>Isa:</b> are contents and goals right in there?</p> <p><b>Lauri:</b> (<i>huffs</i>) I don't know how is it...</p> <p><b>Lauri:</b> Yes, this is okay. But we could still add there because we know that which content is connected to which goal. Because not all the content is connected to all the goals.</p> <p><b>Kaisla:</b> But there is so many of them then.</p> <p><b>Matti:</b> well yes, so we put them like that.. Well it becomes a mess but we can come back to it.</p> <p>GroupA_session1: 00:26:30-00:27:40</p>
Task understanding	There is a disagreement about how task should be conducted between group members or the whole group misunderstands the task or has troubles to understand how it should be done or they leave something undone.	<p><b>Janina:</b> It's very hard to set these goals if you start to think about them carefully and not just put something general.</p> <p><b>Satu:</b> Do they want these to be some spesific goals or can they be more general?</p> <p><b>Janina:</b> Well yes they can be general, but then we have to have some task where you can practice the goal.</p> <p><b>Satu:</b> ah yes..</p> <p><b>Timo:</b> Yes. But it is always like this to set goals.. It is kind of important even though they are often so general like in curriculum as well.</p> <p><b>Minna:</b> Yes, they are so impresice.</p> <p><b>Timo:</b> I think it is often like... It's very simple thing which already makes you to achieve the goal</p> <p><b>Satu:</b> Yes, something simple</p> <p>GroupE_session2 00:48:10-00:49:18</p>
Content understanding	Students have troubles to activate previous knowledge	<p><b>Riikka:</b> Is there such version about ecosystem, in which there is a pyramid and human is like on top of it separatedly? Isn't there something like that? That a human</p>



about the environmental phenomena or about primary school aged children and school. Group members don't understand the studied phenomena during sessions.

is on top of the predators as well?  
**Aino:** At least a modern human, but..  
**Riikka:** I might remember wrong, but I have such kind of image.  
**Aino:** There might definitely be that kind of a theory, but I just haven't heard about it.  
**Riikka:** No, I might just invent this my own.  
**Aino:** It is not a bad theory.  
**Riikka:** Well it is though logical if you think that human hunts predators.  
 GroupC\_session2 00:16:06-00:17:00

### Challenges in interaction and organizing work

Challenges in communication Students have challenges to understand each other's, they don't listen other group members or their way of expressing themselves causes challenges in group atmosphere.

**Outi:** (*yawns*) aa-a  
**Tiina:** I haven't had sneakers before so I just wonder how much I know about this topic, but it doesn't matter, this is still okay to do with others.  
**Outi:** mm-m  
**Kimmo:** Oh, are you having a conversation already?  
**Tiina:** Yes.  
**Outi:** (*laughs and shows the discussion task*) Here Kimmo.  
**Tiina:** What kind of strengths your group has?  
**Kimmo:** I was wondering what do you waffle there.  
 (*Outi laughs*)  
**Tiina:** Didn't you hear? Well, you can still easily join the conversation. Welcome.  
 GroupD\_session3, 00:06:46-00:07:25

Different working styles Students have dissimilar working styles which causes challenges in group work. (Different goals, different vision about the level in which task should be conducted).

**Siiri** (*annoyed*): I just thought to open up these things a little here.  
**Maija:** Yes you can do that, but we..  
**Hilla:** (*annoyed*) yes we just run out of the time.  
**Erkki:** Yes, we have two minutes left from this session.  
**Siiri:** well I will finish these then at home. By the way We still need to the reflection.  
**Hilla:** Okay let's do the reflection so that we don't need to stay over time.  
 GroupB\_session2 : 00:42:40-00:43:54

Division of work Division of work between group members doesn't work, there is no division or group members are not aware of division.

**Siiri** (*writes the task of the group for the computer*): Then. Teaching the theory of the subject. Then? (*Looks at Maija*)  
**Hilla:** Dow e show that video?  
**Maija:** Video? Showing videos?  
**Erkki:** Why do I do this cartoon by the way?  
**Maija:** It is for the final throughput  
**Erkki:** aa, the final throughput, okay. (*Sini laughs*)I just had to make sure..  
**Siiri:** ...that if you are drawing it for nothing or..?  
**Maija:** It is the visualized final throughput.  
**Erkki:** (*joking*) That if you have just externalized me from this task to make me be silent in the corner.  
 (*Siiri and Hilla laugh*)

Challenges in time management

Students are not able to work in given time.

**Siiri** (*annoyed*): I just thought to open up these things a little here.

**Maija**: Yes you can do that, but we..

**Hilla**: (*annoyed*) yes we just run out of the time.

**Erkki**: Yes, we have two minutes left from this session.

**Siiri**: well I will finish these then at home. By the way We still need to the reflection.

**Hilla**: Okay let's do the reflection so that we don't need to stay over time.

GroupB\_session2 : 00:42:40-00:43:54

### Challenges in participation

Maintation of interest

One or more group members doesn't participate in groups work, group starts to speak about something else or do something else (e.g. watching their mobile phone).

(*Kimmo reads something from computer, Tiina ja Simo are trying to solve the task. Outi is following what happens on the other table.*)

**Tiina**: (*reads out loud the web page about the rain*)

**Outi**: (*stares what happens in the other group*) I wish I could also just hang on the feets of the table.

**Kimmo**: (*looks for the table and for the kids which Outi is talking about.*)

**Outi**: Yes, it would be great (*speaks with someone on the other table. Kimmo listens what she speaks*)

**Simo**: *reads out loud the webpage. Tiina laughs.*

**Kimmo and Outi**: *Laugh for the events in other group while Tiina and Simo try to finnish the task.*

Group D\_session5 00:14:41-00:15:17

Participants are tired

Participants yawn, tell that they are tired and tiredness disturbs their working.

**Siiri**: (*sigh*) Should we put here the share between upper and lower level?

**Maija**: We should clarify it somehow (*silence*)

**Erkki**: *yawns*

**Siiri**: (*laughs*) Tired?

**Erkki**: Yes.

**Hilla**: Easter holiday begins.

**Maija**: Luckliy we have a holiday, I need that.

**Hilla**: exactly

**Erkki**: yes.

**Siiri**: Oh, I will be studying for the exam.

**Hilla**: which exam do you have?

**Maija**: I should also do some studies, but if I would just rest couple of days.

Group B\_session2, 00:30:08-00:31:02

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### External challenges

Devices don't work

Devices don't work and it interrupts the learning.

**Satu**: *Takes the tablet.* So keyboards didn't work here, right?

**Minna**: *is trying to work with laptop.* At least we couldn't make it work. But I'm not sure if we tried the other one.

What is this laptop doing now?

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		<p><b>Jenni:</b> I have my own laptop with me and there is keyboard if that doesn't work.  <b>Minna:</b> So should I go here?  <b>Janina:</b> Yes, sure. <i>Yawns</i>.  <b>Satu:</b> Well I just turned this on. But not then...  <b>Timo:</b> I don't think it works because here is so many devices that they mix the keyboards.  <b>Satu:</b> Really? O shit..  <b>Minna:</b> This laptop is quite slow.  Group E_session3, 00:30:40- 00:31:32</p>
Use of ICT tools	Students don't know how to comment other groups' work, they don't know how to upload the file in google drive, or they don't find the project folders.	<p><b>Janina:</b> Open in drive. What? New document, oh it puts.. This is a bit slow. Annoying when this display is so small when I have used to have bigger even with tablet.  <b>Minna:</b> mmm.. Create a new document  <b>Janina:</b> Where can I create it from? Here? Is this google docs?  <b>Minna:</b> But what are these other files?  <b>Janina:</b> Well it's something look. What someone else has uploaded. Is this the google docs?  <b>Minna:</b> Yes.  Group E_session3 00:33:03-00:33:54</p>
External interruption	Something interrupts groups work, e.g. other group, group member exits the session or mics don't work.	<p><b>Outi:</b> Hey your mic doesn't work.  <b>Tiina:</b> oh, how has it shut down?  <b>Outi:</b> if the battery is low  <b>Tuuli:</b> (<i>says for teacher</i>), Hey, I have empty battery in this  <b>Simo:</b> low battery  <b>Outi:</b> Okay, I will leave now, bye (<i>Leaves</i>)  Group D_session 5, 00:46:15-00:46:47</p>

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## Appendix 2.

Appendix 2. Challenge amounts of different subcategories during all the analyzed sessions

Table a. Groups A, B, C

Challenge	A1	A2	A3	B1	B2	B3	B4	B5	C2	C3	C4	C5
<b>Knowledge construction</b>	1	1	0	2	4	2	0	1	0	0	2	2
<b>Content knowledge</b>	2	3	2	1	3	1	3	3	4	2	2	3
<b>Task understanding</b>	0	0	2	1	0	2	1	2	1	1	1	2
<b>Can not maintain interest</b>	0	1	0	1	2	7	0	4	2	3	4	2
<b>Tiredness</b>	0	0	0	0	1	0	0	0	3	1	0	0
<b>External interruption</b>	1	1	2	1	0	4	1	0	0	0	2	6
<b>Devices do not work</b>	1	2	1	1	1	2	1	1	3	2	0	1
<b>Use of ICT tools</b>	0	1	0	1	0	0	0	1	2	1	1	2
<b>Management of time</b>	0	0	0	0	0	1	0	1	0	0	0	1
<b>Communication</b>	3	0	1	1	0	0	0	2	1	0	1	0
<b>Division of work</b>	0	0	0	0	5	5	1	1	0	0	2	0
<b>Differences in working styles</b>	3	2	0	0	0	0	0	0	1	0	0	0
TOTAL	11	11	8	9	16	24	7	16	17	10	15	19
Challenges in understanding	3	4	4	4	7	5	4	6	5	3	5	7
Challenges in participation	0	1	0	1	3	7	0	4	5	4	4	2
External challenges	2	4	3	3	1	6	2	2	5	3	3	9
Challenges in interaction and Organizing work	6	2	1	1	5	6	1	4	2	0	3	1

Table b. Groups D and E.

Challenge	D1	D2	D3	D4	D5	E2	E3	E5
<b>Knowledge construction</b>	2	2	0	2	0	4	4	0
<b>Content knowledge</b>	1	3	7	2	2	6	3	4
<b>Task understanding</b>	2	0	1	1	0	1	0	1
<b>Can not maintain interest</b>	1	0	4	0	2	1	0	0
<b>Tiredness</b>	1	1	1	0	0	0	0	0
<b>External interruption</b>	0	3	1	2	3	1	1	1
<b>Devices do not work</b>	0	5	1	2	0	2	1	3
<b>Use of ICT tools</b>	1	2	1	0	0	0	2	1
<b>Management of time</b>	1	1	1	1	0	3	1	0
<b>Communication</b>	1	0	3	0	0	4	0	1
<b>Division of work</b>	0	2	0	0	0	0	0	1
<b>Differences in working styles</b>	0	0	1	0	0	1	1	0
TOTAL	10	19	21	10	7	23	13	12
Challenges in understanding	5	5	8	5	2	11	7	5
Challenges in participation	2	1	5	0	2	1	0	0
External challenges	1	10	3	4	3	3	4	5
Challenges in interaction and Organizing work	2	3	5	1	0	8	2	2