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COLLABORATIVE DISPOSITIONS, KNOWLEDGE CO-CONSTRUCTION AND MONITORING IN COLLABORATIVE PROBLEM SOLVING

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Dispositions are trends or frequencies of acts performed consciously, habitually and automatically, influenced by beliefs, attitudes, personal values or commitments (Katz & Raths, 1985; NCATE, 2002). Thus, collaborative learning dispositions are students' commitments, beliefs, contributions, or attitudes towards collaboration (Wu, Ho, Lin, Chang, & Chen, 2013). In a similar context, a person who has a certain level of disposition will display certain behaviors, so dispositions can be used to predict behaviors that may occur (Katz & Raths, 1985). To enhance learners' collaborative learning skill, it is necessary to start from teacher students' collaborative learning dispositions, which may potentially have impacts on their future students' learning opportunities.

This study aims to investigate what kinds of activities students focus on during collaborative learning processes. Also, the research explores whether there is any difference in the way students demonstrate and contribute diversely in group work when they possess different collaborative disposition scores, measured by questionnaires, which were based on a research by Wang, MacCann, Zhuang, Liu and Roberts (2009). Videos from five groups of teacher students (N = 14) were collected and observed. First, the process-oriented qualitative analysis was carried out to assign meaningful events to separate categories of knowledge co-construction and monitoring activities. Then, quantitative analyses were conducted to explore activities executed most regularly as well as correlation between collaborative disposition scores and students' contributions.

The results of video data, gathered from the PREP21 project indicate that participants were actively sharing ideas, showing approval or disapproval about members' contributions. Also, they frequently monitored how group tasks had progressed, then suggested following actions. Unexpectedly, there was no considerable relationship between measured collaborative disposition levels and enacted individual level collaborative problem-solving contributions. However, in a case study analysis, active and passive students displayed differently. Additionally, interconnection between knowledge co-construction and monitoring were shown.

Keywords: Collaborative learning, Collaborative problem solving, Collaborative disposition, knowledge co-construction, monitoring.

Contents

List of Tables and Figures

Tables and figures **Pages**

1 Introduction

Collaborative learning first emerged in the 1970s due to practical reasons when students had to share scarce learning resources. It has gradually achieved popularity when the society has emphasized the need of working together in schools or working places, especially in the globalized world with the support of Internet and technologies (Baker, 2015). Collaborative learning concept has covered a wide range of fields, from cognition, metacognition, educational technology, sociology to computer-supported collaborative learning (O'Donnell & Hmelo-Silver, 2013). In the 21st century, collaborative learning is one of the key skills required. Also, collaborative problem solving (CPS) is a crucial and demanding skill in which learners work together to solve a problem that is hard to achieve individually.

According to Saab, van Joolingen, and van Hout-Wolters (2005) synthesis about collaborative learning in general and constructing knowledge activities in particular, collaborators need to possess various skills to ask questions, providing answers with meaningful concepts and clear explanations. In addition, they are required to be aware of their own cognitive and metacognitive processes. Due to the involvement of various concepts and skills, during these complex processes, possible faults and unwanted issues can happen. That is the reason why collaborative learning and mutual interactions among members are not always equal to successful outcomes (Barron, 2003).

In order to have better competency in collaborative learning, it is needed to train the above-mentioned skills. However, collaborators, except from knowledge and skills, need to have affirmative dispositions towards collaboration, which helps students to be more enthusiastic and willing to collaborate (Fransen, Weinberger, & Kirscher, 2013). Nevertheless, teachers are hesitant to apply collaborative learning in teaching (Baines, Blatchford, & Kutnick, 2003), and teacher students are not willing to collaborate while learning (Ruys, Van Keer, & Aelterman, 2010). This, indeed, can influence frequency and quality of collaborative learning of future generations of students. In 1985, Katz and Raths highlighted that dispositions should be included in the goals of teacher education. Therefore, if collaborative dispositions are embedded in teacher training programs, it is possible to strengthen desirable collaborative learning dispositions and weaken undesirable ones (Katz & Raths, 1985). This can contribute positively to teacher students collaborative learning skills, which will potentially affect their students' learning opportunities in the future.

Additionally, dispositions towards collaboration affect a successful teamwork and quality of collaborative processes (Wu et al., 2013). Also, collaborative dispositions are assumed to be impacted by their strategic skills, which are indicated, for example, by how students use cognitive and metacognitive strategies and learning environment (Häkkinen et al., 2020). Hence, inclusion of collaborative dispositions in teacher students' curriculum and creating collaborative learning situations can enhance desired dispositions towards collaborative learning, for instance, cooperative mindset or negotiation (Häkkinen et al., 2020). Furthermore, Häkkinen with colleagues (2020) indicated that considering a whole group as a learning unit may overlook learners' processes of cognition, motivation or attitude in collaborative tasks. In the same vein, approaching from an individual standpoint can benefit improvement of assessing individual learning process and performance (Swiecki, Ruis, Farrell, & Shaffer, 2020). Also, considering from an individual perspective enhances comparisons of students' learning outcomes when they conduct tasks individually or collaboratively, facilitating collaborative learning and collaborative problem solving processes (Chang et al., 2017). Therefore, this research will also focus on the individual level to provide a clearer approach to collaborative activities.

2 Theoretical framework

2.1 Collaborative learning

Collaborative learning is defined as a situation in which two or more people strive to learn something together (Dillenbourg, 1999). Specifically, learners can work in pairs, small or large groups to learn course materials or solve problems together. Those learning activities can happen in various contexts from face-to-face, online to synchronous or asynchronous learning environment, as long as the workload and effort are divided among members in an organized way. A similar definition was mentioned by Smith and MacGregor (1992). Also, collaborative learning is expected to shift away from the teacher-centered to the student-centered method in which teachers' roles are designing learning activities instead of transmitting knowledge (Laal & Laal, 2012).

Collaborative learning benefits learners in various ways. When students actively engage in task accomplishment and group interactions, they develop problem-solving skills, thinking skills, communication skills, commitment to accomplish tasks, deep learning, or self-regulation, (Laal & Ghodsi, 2012). Apart from that, it helps to increase responsibility, self-esteem, develop leadership skills, or generate chances to take diverse perspectives into consideration, preparing for real-world social and working situations (Chandra, 2015). In other words, collaborative learning enhances learners' understanding during processes of collaborative discussion and negotiation, which can contribute to expanded knowledge and skills of learners which are hard to attain on their own (Dillenbourg, 1999).

On the other hand, even though collaborative learning has shown advantages to learners, there are some issues that remain. Collaboration can be difficult for individual learners, resulting in time-wasting and demotivation (Salomon & Globerson, 1989). In a research of Barron (2003), if students joined a group with successful outcomes, they attained better scores in the solo phase afterward. However, when students worked in a less productive and less successful group, even though they scored higher than what the group had done, they got similar results if they had been asked to solve the task on their own from the beginning. This indicated that collaborative learning is not self-evidently beneficial for learning outcomes.

Collaborative learning is challenging for students as it happens in the relations between four aspects: situations (e.g., learners have a similar knowledge level, take similar actions share goals and work together), interactions (e.g., whether or not group members are having synchronous discussions or doing something together), processes (e.g., workload is shared among members, conflicts of knowledge or viewpoints happen between members) and effects of collaborative learning (Dillenbourg, 1999). Specifically, those elements do not occur in a simple linear causality but more often reciprocally. For example, situations and interactions are two-way connected, in which situations (e.g., members' levels of prior knowledge) affect how participants interact with each other. On the other hand, some situations are called collaborative learning when participants produce collaborative interactions, such as negotiable conversations in which participants discuss and reason their viewpoints, negotiate and make an effort to convince team members (Dillenbourg, 1999). Due to various factors involved and happening under the umbrella of collaborative learning, the skill needs to be taught. For instance, interactions can be facilitated by constructing initial conditions, specifying participants' roles, scaffolding interaction processes, and monitoring interactions (Dillenbourg, 1999). However, it still requires learners to have positive collaborative dispositions, for instance, cooperative mindset, team leadership and negotiation, to achieve better (Häkkinen et al., 2020).

2.2 Collaborative dispositions

Collaborative learning and group problem-solving processes involve social skills in which students interact with each other to figure out solutions (Dillenbourg, 1999; Hesse, Care, Buder, Sassenberg, & Griffin, 2015). Indeed, during the learning process, they have to develop group organization, from building a relationship among members, understand tasks (*forming*), dealing with interpersonal and emotional conflicts (*storming*), negotiate goals and used strategies (*norming*), attaining solutions (*performing*) to evaluate group's performance and compare to personal goals (*adjourning*) (Tuckman, 1965; Fransen et al., 2013). They need to share understanding about task targets, determine strategies, distribute group resources, or construct mutual trust that every member is taking actions towards team success (Tuckman, 1965; Fransen et al., 2013). Hence, in order to perform well, learners need not only cognitive skills but also collaboration skills with other group members (Hesse et al., 2015; Sears & Reagin, 2013; Häkkinen et al., 2020).

Collaboration interaction can have a positive or negative influence on performance (Sears & Reagin, 2013). Though collaboration has the potential to reach unique outcomes that are hard to attain without interaction, students may fail to perform their best abilities, which in turn affect group effectiveness (Barron, 2003). Collaborative skills can be enhanced by technological tools, teaching methodology, or a supported learning environment with explicit instructions. However, as being mentioned above, learners still need to have affirmative dispositions towards collaboration (Häkkinen et al., 2020).

In general, the term disposition, viewed from previous research, has been vaguely used (Schussler, 2006). For example, in the early use of the concept, studies used the term without clearly defining it, for example, Barnes (1989) or Strom (1989). While Barnes (1989) neither mentioned why dispositions were important in learning nor how to achieve dispositions, Strom (1989) equalized dispositions and feelings, which was inaccurate according to Schussler (2006) interpretation. Also, Schussler (2006) viewed that disposition was rather ambiguously considered as beliefs of teachers (Korthagen, 2004), or sense of the psychology of community (Sarason, 1974) and learning community (Schussler, 2003).

In 1985, Katz & Raths defined dispositions as trends or frequencies of acts, meaning that dispositions may include conscious, deliberate, habitual and automatic acts. However, dispositions are not the cause of behaviors (Jung, Rhodes, & Vogt, 2006; Katz & Raths, 1985). Instead, they are the frequencies or trends of acts in a particular context (Katz & Raths, 1985). Disposition can be defined in situations specifically by focusing on behavioral acts. This means that in a certain situation, teachers who are in a certain level of disposition will demonstrate a certain behavior. Thus, dispositions are basic predictions of future trends in behaviors. In other words, dispositions cover behaviors, actions, manifested skills, competence, beliefs, etc. to end up with observable behaviors. Also, positive dispositions can be enhanced by training during the learning process (Katz & Raths, 1985). For example, in teaching context, teacher students should have a disposition to evaluate their teaching methods and modify or replace them appropriately, based on their recognition of such context as students' ongoing discussions.

Later, the concept was also clarified in NCATE (2002, 53), which defined dispositions in teaching context as:

"The values, commitments, and professional ethics influence behaviors toward students, families, colleagues, and communities and affect student learning, motivation, and development as well as the educator's own professional growth. Dispositions are guided by beliefs and attitudes related to values such as caring, fairness, honesty, responsibility, and social justice"

Schussler (2006) explained disposition in the context of teachers. It is said that dispositions function as a point of convergence as well as inception. Regarding convergence point, it is the place where external influences of the teaching environment meet the teacher's individual internal schemata. When facing a teaching situation, how the teacher perceives, filters information, and acts upon is disposition. It involves cognition, beliefs, values, culture, and prior experiences. Additionally, dispositions are points of inception where teacher's thinking and actions are generated. The origin where their knowledge and behaviors produce are teacher's dispositions. It is the guiding source for teachers to process knowledge, and dispose to use their knowledge and skills towards teaching situations.

It is evidenced that teachers' cognitive attributes (e.g., academic skills, domain knowledge, or reasoning capability) and other personal characteristics (e.g., self-efficacy, beliefs, motivation, attitudes or dispositions) influence teachers' professional practices

(Klassen et al., 2018). On the other hand, teachers are playing important roles in students' learning (Kane et al., 2013). Thus, when collaborative dispositions are embedded in teacher training programs, teachers have chances to practice, then placing enduring impacts on future students' collaborative learning dispositions and skills (Häkkinen et al., 2020).

When applying this concept to the collaborative context, it can be understood that dispositions of deliberate commitment, interactive contribution, ongoing adjustment, or inclusive cooperation are necessary to attain a successful collaboration (Wu et al., 2013). Hence, to be successful in collaboration and contribute to the group work, besides members' abilities and expertise, they also need positive dispositions.

This article views dispositions as teacher students' attitudes towards collaboration, collaborative problem solving, and teamwork, which is based on the research of Wang and colleagues (2009) and Häkkinen and colleagues (2020). The approach considers dispositions in collaborative problem-solving in teamwork, including cooperative mindset, team leadership and negotiation. A cooperative mindset means general attitudes towards teamwork or collaboration. Negotiation disposition is the willingness to negotiate, listen, take others' viewpoints into account and adjust their actions in group work. Finally, Team leadership refers to dispositions towards guiding members in a group, advocating, and taking responsibility for the group outcomes.

2.3 Collaborative problem solving

Collaborative problem solving (CPS) means that learners approach and solve a problem responsively by working collaboratively and exchanging ideas (Hesse et al., 2015). First, collaboration is a helpful and necessary tool needed for complicated problems where members need to organize their activities to tackle a specific task or problem. Those activities are inseparably intertwined, collectively constructed upon each other, meaning that one action can be adopted, continued and then finished by another (Hesse et al., 2015).

On the other hand, in problem solving activities, learners observe differences and disparities between a current state and a goal one, then strive to work on that situation to reach the desired goal state (Hesse et al., 2015). Problem solving includes mental and behavioral processes that can occur simultaneously and not necessarily in sequential manner (Hesse et al., 2015). Hesse et al. (2015) has formulated a five-step framework of problem solving. First, a problem indicated by a difference between current and desired state is recognized. Second, learners make problem space of problem states, and steps can be taken to make transformation between the states. Next, a plan for those steps is created, then the plan is conducted. Finally, the progress towards the solution is monitored.

Hesse et al. (2015) has defined CPS as a joint activity where pairs or small groups of students conduct steps to transform a current state into a desired one. CPS is especially beneficial when learners encounter problems that are complex. CPS demands each member to identify a problem and what aspects or factors from the problem that individual can monitor (Hesse et al., 2015). During group work, learners recognize the problem and elements belonging to that problem space, then notify group members of the difference between the current state and the targeted one (Larson & Christensen, 1993). Additionally, there is a need to control and manage group resources, meaning that members are aware of who knows what, and who has figured out which problem elements. Besides, members should consider, monitor group processes, for instance, what problem they have faced or availability of resources in the group (Peterson & Behfar, 2004).

Thus, as can be seen, CPS is a complicated process including interconnected activities among members. CPS places students among a variety of solutions, and they need to address various perspectives as well as regulate their own attitude while handling those problems (Rahikainen, 2002). During cognitive processes, metacognitive knowledge and skills are involved to help learners monitor the processes, for instance, estimate their own understanding of tasks (Rahikainen, 2002). It is more important that learners are aware of when to use strategies and what strategies that need to be used (metacognition) rather than knowing strategies only (cognition) (Carrell, Gajdusek, & Wise, 1998). Thus, metacognition is essential and plays a vital role in making cognition effective (Gourgey, 1998). Similarly, Hurme (2001) argued that problem solving from collaboration can uncover metacognitive aspects as an essential output of learning.

2.4 Knowledge co-construction activities in collaborative learning

In collaborative learning, learners take part in knowledge co-construction activities to interact with group members to build new knowledge and develop, expand knowledge and understanding of each student (Janssen et al., 2009). In knowledge co-construction process, learners work together, share responsibilities, share their expertise to other members then discuss and construct based on each member's ideas (Palincsar & Herrenkohl, 2002).

In a research of Beers, Boshuizen, Kirschner and Gijselaers (2005), knowledge co-construction starts from unshared knowledge of an individual and develops to constructed knowledge of a group. This incorporates three forms (external knowledge, shared knowledge and common ground) that go through four processes (externalization, internalization, negotiation and integration).

In detail, when individuals externalize their unshared knowledge, for instance, by sharing information to ongoing group conversation, other members can try to internalize it. Various aspects can be taken into consideration to comprehend the contributions better, such as contributors' background or current situation. Additionally, listeners' beliefs and assumptions partly affect how they understand the speakers' contributions, and this also leads to differences in interpretation in each individual's mind (Beers et al., 2005). Common ground is then negotiated after members internalize contributions, providing feedback formed on their own perspectives (Alpay, Giboin & Dieng, 1998). Common ground is continuously gathered and updated, but never absolute (Clark & Brennan, 1991). Next, integration helps building new knowledge by adding new concepts to common ground that was once built by the whole team.

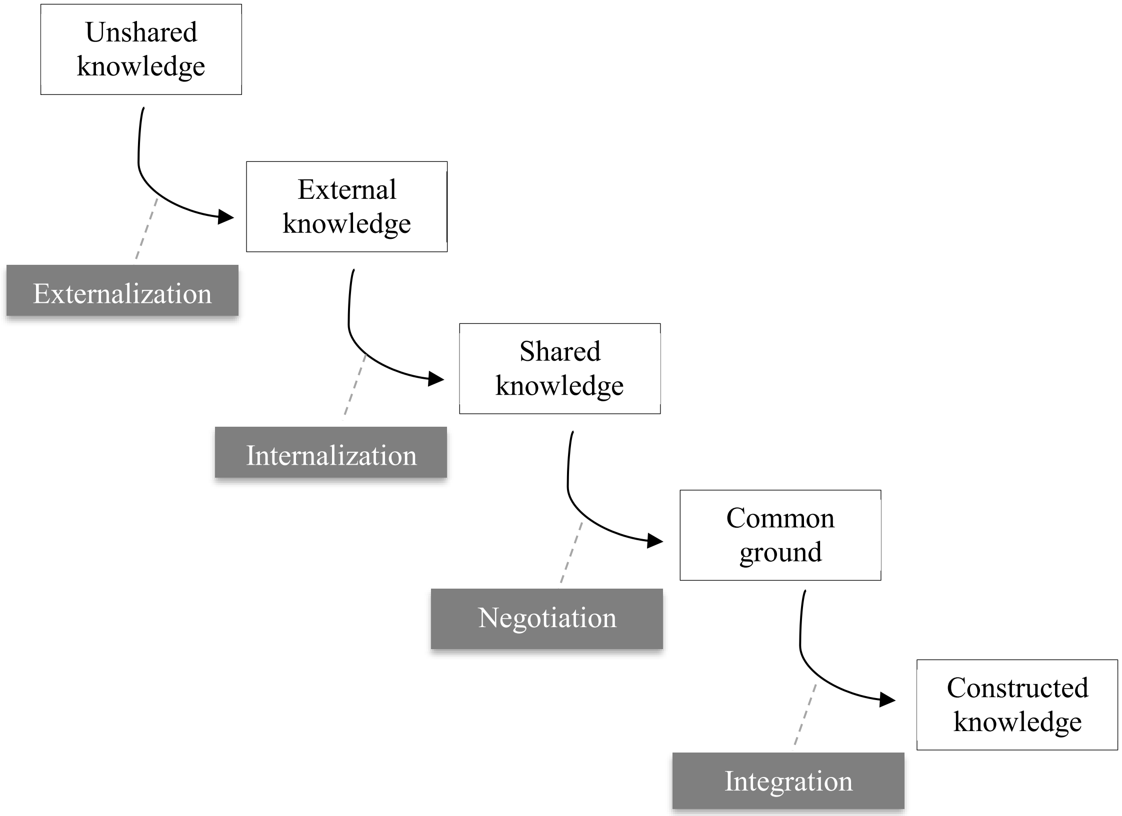

Figure 1. Framework of knowledge co-construction process (Beers et al., 2005)

Thus, knowledge co-construction process, generally stating, can help learners to reach new knowledge by first sharing information among group members, then internalizing information at individual level to attain a common ground. Knowledge is next negotiated and constructed to acquire group constructed knowledge which, in collaborative problem solving context, appears in the form of solutions. Knowledge co-construction processes involve learners in purposeful problems, using and taking advantage of authoritative sources in a productive and critical way. Also, they share the same goals of progressing to construct knowledge and ultimate solutions (Bereiter & Scardamalia, 2003). During the processes, when students constantly share thoughts, as well as evaluate, compare those shared ideas in mind, in order to figure out discrepancies that are against prior perspectives, learners need to embrace metacognitive activities. Metacognition is also needed in negotiation phase where students evaluate current situation to decide if it is necessary to re-verify, re-explain their contributions or re-check if their opinions are clear or not. Hence, knowledge construction happens if individuals proactively participate and shoulder responsibility for not only their own but also group members' learning (Rogoff, Matusov, & White, 1996).

In collaborative learning, those four processes can occur as interpretation, reasoning, critique, analysis or summary (Zhu, 2006). Similarly, Van der Meijden (2005) argued that students' knowledge co-construction is illustrated by asking questions that request explanations, answering with elaboration and reasons, and providing new ideas with clarification. Finally, they either accept or reject members' contributions with presented arguments. In this study, knowledge co-construction processes are considered by sharing knowledge, asking questions, providing answers and summarizing after group discussions (Vuopala et al., 2019).

Indeed, learners are able to learn more by sharing experiences during group discussions (Vygotsky, 1980), and this process enhances making public of one's individual knowledge (Marshall & Brush, 2004). Besides, by asking and answering, learners are arguing, providing justification, explanation and evidence to other participants. This kind of communication is necessary for a high level of problem solving process and knowledge construction (Shukor et al., 2014). Finally, summarizing is built upon group members' contributions after discussions. The activities of identifying main ideas or concluding details help learners to monitor and check if the materials or discussions are understood well. Incapacity to summarize alarms incomprehension or incomplete understanding among members. Summarizing skill also enhances memory due to reconstruction of information, which can facilitate next similar learning situations in terms of built knowledge and metacognitive skill (King, 2007). While explaining students' perception and understanding that are still in the development process, they learn more successfully (Baker, Hansen, Joiner, & Traum, 1999).

2.4.1 Content-related questions and answers

This research pays closer attention to what extent students asked questions and provided answers. The reason is that students are able to gain better learning outcomes if the high-order thinking processes happen during group discussion, such as asking thought-provoking questions and elaborating answers (Veenman, Denessen, van den Akker, & Van Der Rijt, 2005).

Thought-provoking questions are proved to facilitate higher learning (King, 2007). Such questions prompt learners to perform high-level cognitive processes, for example, comparing, contrasting, thinking about causes and effects, evaluating and justifying ideas, etc. (King, 1994; Kollar & Fischer, 2010). Roscoe and Chi (2008) mentioned similarly that deep questions enhance learning opportunities better than shallow ones. Deep questions demand ability of elaboration, explanation, inference or logical reasoning, while shallow ones are asking definitions or verifying facts only.

As mentioned, thought-provoking questions trigger complex answers, which are detailed elaboration and explanation. They go together with examples, concept explanations or specific argumentation (Webb & Farivar, 1994). Specifically, verbal explanation promotes cognitive process, including reflection, (re)organization, differentiation, perspective comparison and knowledge expansion (Van Boxtel, 2000).

Additionally, Näykki, Järvenoja et al. (2017) synthesizes several reasons why asking questions and producing elaborations is advantageous for learning. First, by making clear their ideas in discussions, learners are able to monitor, organize knowledge, then transform it into complete and coherent verbal form for other students to comprehend. Learners may recognize information incompleteness or misunderstanding during the explaining process. Second, understanding gaps can be recognized while students are listening to their peers' opinions. Third, when students' ideas are asked and justified, it is a learning opportunity in which they develop new ideas or construct connections between new and prior information.

2.5 Monitoring in collaborative learning

While learning together, students regulate their cognition, motivation and behavior (Järvelä & Hadwin, 2013). In other words, students need to monitor their thinking, beliefs, strategies, goals, motivation, and emotion during the working process. Regulating those factors help students transform environmental contexts, themselves and their team members (Järvelä & Hadwin, 2013). In group work, learners not only monitor their own cognition, but also monitor another member's cognitive activities as well as the whole team's collaborative cognitive activities (Volet, Vauras, & Salonen, 2009). For example, students self-evaluate if their answers for group tasks are correct, while evaluating answers from group members and discussing if the group joint solutions are accurate or need modification (Volet et al., 2009). Thus, monitoring is indispensable and embedded in collaborative learning processes.

Haataja et al. (2018) provided reasons to confirm why monitoring is essential in collaborative learning. During group process, when monitoring is shared among members, students are more knowledgeable about their cognition by learning judgement or senses of difficulty, notice issues happening, try to solve problems towards agreed goals, evaluate group processes and make adaptation to challenges. Besides, a high-level monitoring can enhance group support and explanation, leading to elaboration and revision to task responses. This, hence, activates deeper understanding of content. On the contrary, if the group performs a low-level of monitoring, it has potential to hinder task understanding at a deep level within the group (Rogat & Linnenbrink-Garcia, 2011).

To be specific, socio-cognitive monitoring refers to evaluating not only one's own but also other participants' understanding, cognition and working progress (Näykki, Järvenoja, et al., 2017). This means that students regulate their own and group members' cognitive processes of learning, thinking and content understanding in each situation to reach successful group performance. It is studied that when students are able to monitor thinking and understanding, they gain a deeper level of learning process, compared to groups in which thinking and understanding processes are not regulated. Besides, monitoring thinking and understanding contributes to high quality of engagement in group work and triggers high-level questions and answers in the knowledge co-construction process (Lee et al., 2015; Näykki, Järvenoja, et al., 2017).

These findings align with studies of Johnson and colleagues (2007) as well as Malmberg, Fincham, Pijeira-Díaz, Järvelä and Gašević (2021) in which the importance of monitoring is indicated. Individuals work towards shared goals and signal to members when group progress is not on the right track or make sure that each participant is contributing to the joint outcome of the task.

All in all, during the process of knowledge co-construction in which students go through different phases to transactively contribute to the group's shared knowledge and solution, monitoring of overall collaboration processes and its task-related elements.

3 Aim and research questions

Due to the high demand of collaboration and collaborative problem solving in modern working and learning, many studies have been conducted. However, most existing studies on teamwork have emphasised on a group's outcome, and less focused on how individuals perform during the collaborative task (von Davier & Halpin, 2013). Thus, this study will investigate a research gap in how members with different collaborative dispositions will perform in knowledge construction and monitoring activities.

The particular research questions are:

1. What are students' general disposition levels towards collaborative learning?
2. How do the students participate in knowledge co-construction and monitoring activities in collaborative problem solving?
3. Do the disposition levels of collaborative learning have an effect on how students participate in collaborative problem solving?

Hypothesis: disposition levels positively correlate to students' contributions in terms of monitoring and co-constructing knowledge. It means that the higher the disposition level, the better that student will perform during group work.

4 Methodology

The study focuses on if there are significant differences in constructing knowledge as well as monitoring task-related issues or motivation if students have different levels of collaborative disposition. From that, the relationship between disposition scores and individual performance is generalized. A case study is conducted to investigate a little deeper how knowledge co-construction and monitoring activities are actually happening within the group, and how they are related to each other.

4.1. Data collection and participants

The study makes use of videos collected in the PREP21 project (Preparing Teacher Education Students for the 21st Century Learning Practices), funded by the Academy of Finland. The project was conducted in the collaboration of researchers from University of Eastern Finland, University of Jyväskylä and the University of Oulu. The PREP21 project was designed to analyze collaborative learning skills of teacher education students to prepare them for sufficient collaborative learning competency in the 21st century.

The data collection was carried out with the first-year students during a four-year period with 872 participants in total. Data was accepted to be collected by the head of the department, and participants joined the project voluntarily (Häkkinen et al., 2020). The video data was gathered in a course of Mathematics Education where students were divided in groups of three or four. They collaborated in six parts of the course, covering such subjects as Arithmetic algorithms and base ten blocks, Spatial thinking, Fractions, Geometry and measurement, and Learning difficulties in mathematics.

As mentioned, the project involved a large number of students (872), but this study focuses on a much smaller amount of data, including 14 students from the University of Oulu only who were organized in five groups. In the video recordings, they were working with the Arithmetic algorithms and base ten blocks session. There were two reasons why that part of data was chosen. First, participants were speaking in English, while other videos were left out because participants were discussing in Finnish. This hindered and limited researchers who lacked the ability of Finnish language. Second, the aim of this research is analyzing how students with different collaborative disposition scores may behave differently in the knowledge co-construction and monitoring process in collaborative learning, so it is necessary to collect performance from various students in one session, rather than from a small number of students in various sessions.

Major instruments used in the research were online questionnaires about students' dispositions and video recordings of 14 students working in Arithmetic algorithms and base ten blocks with the total length around 5.32 hours. Among 14 students, 21.4% were male, 78.6% were female, and M_{age} was 23.64.

During group collaboration, a script was provided so that students had to follow at the beginning, middle and end of the process (Table 1). They answered the set of questions individually and then among the group members. In a study of Vuopala et al. (2019), reasons how scripts were used were collected. The script's purposes were to structure students' activities, frame their interactions, assist discourses of high-level collaborative learning, enhance cognitive, metacognitive and social processes. Apart from that, scripts positively affect collaborative skills and domain-special knowledge, reduce collaboration pressure, for instance, planning and monitoring the task.

Table 1. Scripts in three phases

Phase	Scripting questions
Orientation	1. What is the purpose of the task? 2. What kind of feelings does the task arouse? 3. What kind of strengths does your group have? 4. What is the goal of your group work? 5. How do you plan your work?
Check-up	1. How has your work progressed? 2. What kind of feelings does your work arouse? 3. What kind of challenges are you currently facing? 4. How will you proceed from here on?

Reflection	1. How would you evaluate your work as a group? 2. How did you reach your result(s)? 3. What helped or hindered reaching your goals? 4. How did you overcome possible challenges?

4.2. Data analysis

4.2.1. Collaborative Dispositions

In order to tackle the first question, questionnaires were used. Students individually stated that to what extent they would agree or disagree to 18 statements about Collaborative Problem Solving skills (Wang et al., 2009). Each statement is followed by a Likert scale from 1 to 7, in which 1 indicates "I completely disagree" and 7 refers to "I completely agree". Particularly, listed items cover various dimensions of teamwork: Cooperative mind set (4 items), Team leadership (6 items) and Negotiation (6 items) (Appendix 1). Scores were counted based on what students stated on 1 - 7 scale, then categorized and displayed as Low (≤ 93), Intermediate (≤ 104) and High (≥ 105). The IBM SPSS Statistics software was used to count proportions of students' collaborative dispositions to identify what disposition level domained.

4.2.2. Knowledge co-construction activities

Regarding the second research question examining students' performance, five videos were analyzed (Total video length = 319 minutes, M_{length} = 63.8, SD = .837). Video data was advantageous in terms of availability of collecting verbal or non-verbal information and interactions of participants (Wang & Lien, 2013). All the videos were first transcribed for an easier analyzing step.

Video data was analyzed by qualitative content analysis with deductive category application approach, in which coding schemes were predetermined and built, based on prior research, then results were interpreted by quantitative analysis (Mayring, 2004; Hsieh & Shannon, 2005). Qualitative content analysis concentrates on students' communication content or contextual meaning of what they are talking about (Hsieh & Shannon, 2005). This method allows the researcher to have an equal treatment with all data units (Krippendorff, 2018). Indeed, when confronted with a considerable amount of data, there is a possibility that parts of data are selected to interpret, or one may change his viewpoints towards favoured hypotheses for easier analysis and interpretation. Thus, in the qualitative content analysis, no matter where pieces of data appeared or who performed those, they are analyzed and categorized equally. Also, researchers are able to formulate context for specific research purposes, which brings meanings to discourse and communication that may not be aware of during normal situations outside of researching (Krippendorff, 2018). For instance, in this study, no matter which student performed a particular activity, or when they performed it, as long as the activity was recognized as a category in coding schemes, it would be counted. Additionally, videos were transcribed into texts in order to understand clearly and deeply the meanings of students' communication.

In these five videos, knowledge co-construction activities of each member were analyzed and categorized into different aspects. This was done to determine if they were behaving differently in group work or not. Videos were splitted into 30-second segments, which was reasonable to observe several turns of conversation without missing any discourses from students which could be meaningful (Isohätälä, Näykki, & Järvelä, 2020). Videos were transcribed then analyzed by qualitative content analysis method, using QSR International NVivo data analysis software.

Discourses were coded using a coding scheme, and findings could be interpreted as well as concluded based on those coded units (Shukor et al., 2014). The study's coding scheme was built based on the ones of Vuopala et al. (2019), Näykki, Järvenoja, et al. (2017) and Shukor et al. (2014) (Table 3 and Table 4). Three coding schemes from those studies shared similarity in the way knowledge co-construction and monitoring activities were analyzed. Regarding knowledge co-construction, Shukor and colleagues (2014) observed how students asked questions, gave answers and gave information. Though the coding scheme structure was organized differently from other two studies, it covered a similar idea of leveling students' questions and answers. Also, research of Shukor modified that when students showed their acceptance or disapproval of other members' contributions, either with or without elaboration, those were counted as "sharing information". This helped include discourses having this sort of meaning into analysis. On the other hand, in terms of monitoring activities, Näykki, Järvenoja, Vuopala and their colleagues investigated into similar categories to make monitoring visible. In this research, the categories from those three coding schemes were combined.

Moreover, coding criteria of each category were separate and different from each other, going with data examples for easier understanding. However, there were some codes that could be put in different categories if they conveyed various meanings (Table 2). Eventually, 20% of all the analysed data was re-checked by an independent colleague to define inter-rater reliability. Cohen's kappa coefficient of each category was counted and shown in Table 3 and 4. Cohen's kappa illustrated a good agreement between two researchers to prove that the data was interpreted correctly.

Table 2. Example of overlapping codes

Student	Time	Turn	Transcript	Category
4	44:04 - 44:06	1	Doing this way, you got 15, right?	Question _ Low
1	44:09 - 44:14	2	But before you do that, you don't want to put all the…	Share information Task progress
4	44:16 - 44:17	3	OK, I'll do that way	Share information Task progress

There were two aspects that needed to be covered, namely content-related activities and monitoring activities. During the collaborative process, students made some off-task chat and off-task technical talk, which were excluded from the analysis. Off-task chat is the one irrelevant to the task, while off-task technical talk is still related to the task, for instance, learning environment, but does not cover the major content of the task (Saab et al., 2005). Off-task communication contributes to the group atmosphere. Those can be used to monitor negative feelings like boredom or frustration (Carpenter et al., 2020) and may benefit knowledge co-construction procedures (Vuopala et al., 2016). Off-task behaviors were not transcribed or used in the analysis. Furthermore, communication between facilitators and students was also omitted. Only conversations among group members were carefully considered.

Content-related activities

The analysis proceeded by firstly exploring content related questions and answers. Second, questions and answers were classified into High, Average and Low levels. High-level questions were the ones requiring broad explanation, elaboration and deep content understanding, while average-level ones demanded a bit of elaboration, and low-level ones were about fact checking, yes-no and needed no elaboration. Content-related answers, in the same vein, were organized into three categories. High-level answers showed detailed elaboration which indicated clear understanding of content. Besides, average-level answers demonstrated some details and elaboration, while low-level ones were short answers or yes-no replies without any elaboration.

In addition to questions and answers, the analysis explored how students shared information and summarized their discussions. The category of sharing information included activities in which students shared new information, ideas, thoughts or concepts in collaborative discussions. Those could have derived from an individual's own experiences, a commonly known fact, prior information, which were shared with or without elaboration. Also, students could indicate their agreement or disagreement to another member’s sharing, with or without following clarification. Moreover, they showed acceptance towards other learners’ contributions, with or without elaboration. The last knowledge co-construction activity was summarizing in which participants made conclusions after discussions (Table 3).

Table 3.

Coding explanation and data examples of Content-related activities

Cohen's	Category		Coding explanation	Data example
0.617	Question	High-level	Content-related broad questions that require detailed explanation and answers, demand a high level of content understanding.	"What's the algorithm?", "How would you teach it? Because in this activity, we are not supposed to have these, so how would you teach what he just said?", "Why do we put the one here? How do I explain that to a kid?", "What other ways do you think we can do it?"
		Average-level	Content-related questions, but not broad ones. Questions ask for some level of explanation and not so detailed elaboration.	"Do you think this would be too hard for a kid to understand?", "But even if you do it that way, could you identify it right away that it's more than 9?"
		Low-level	Content-related questions which require sharing facts and information only, not demand any level of elaboration.	How many left?", "So that's 10 exactly, right?", "So then we take 6 away? And this

				is the result that we are left with, yeah?”
0.593	Answer	High-level	Content-related answers with detailed elaboration, explanation, and may have examples, showing a high level of content understanding	“Well, because if it’s in the middle, or in the end of the number, it’s not nothing. It has a value. If it comes before this, so it would be 0227, then that zero has no value”, “I think we would do it in steps. You want to take out 4, so what would you do? You can’t physically take out 4, so you gotta convert within one, do you convert this into 10…”
		Average-level	Content-related answers with some elaboration and explanation	“You have to show that you can’t borrow from minus, but you can borrow from this”, “I guess you just have to change this. You can put yellows instead of this”
		Low-level	Content-related answers with no elaboration and explanation, just sharing facts and information only.	“I think they are the same”, “Zero”, “This one, yeah it’s 1000”, “That would become a unit… I mean a 10th”,

			"It's 1 2 3 4 5 6… 1 2 3 4 5 6… 66"
0.762	Sharing information	Giving information, idea or thought with or without further explanation. The produced information may come from personal experiences or it is a normally known fact. Indicating acceptance or denial of contributions of other participants, with or without explanation. Refer to earlier information	"I'm assuming it is a thousand… hundred…tens…", "I think the colors help as well", "But this way we can't because there is nothing on that side", "It should be 800", "I think by the time they get to that level, they would have more of an understanding of the basics. They do not need placemats", "OK so then over here, she did 20x3... and then 20x10".
0.742	Making summaries	Summarizing, concluding content after discussions or reviewing previous discussions	"So then it's 422", "Slower one would be easier", "So without even counting like doing the sum individually or splitting the numbers, you can just add the sum together by putting the blocks on top of each other. But I

			think it would be better to do it like you did: change it to 10s before playing with the 1s”

Monitoring activities

Throughout learning time, students monitored tasks, progress and cognition in many ways. First, they monitored task understanding, checked if they understood task framework, task components, purposes and guidance. Second, task progress was monitored by reviewing what they had done, and by making suggestions of what they should do next. Third, monitoring of content understanding referred to students' consciousness of their own content understanding or lack of content understanding. This encouraged them to seek help, demanded content understanding from other members or expressed willingness to share content understanding. Additionally, students showed their interests in tasks and recognized if there is a shared interest among members. Finally, participants indicated and reflected their feelings or thoughts about challenges or issues faced during carrying out the tasks (Table 4).

Table 4.

Coding explanation and data examples of monitoring activities

Cohen's	**Category**	**Coding explanation**	**Data example**
0.709	Task understanding	Monitoring one's own and others' awareness about task understanding, task framework, task components, task purposes and guidance,	“After answering the first page, we have to open up the Ipad?”, “So 5 minutes to talk about this”, “Learn to use the base ten,

		request shared awareness of task understanding	different ways to use in class or introduce it…”, “It is asking for additions and subtractions”
0.752	Task progress	Monitoring one’s own and others’ awareness about group progress, suggesting what they should do next, request shared awareness of task progress	“We take the 10 green ones out and replace them with this”, “Should we try to do the ones with minuses?”, “We haven’t done the work. We haven’t calculated anything”, “OK next one, 338 minus 129”
0.692	Content understanding	Monitoring one’s own and others’ awareness about content understanding or lack of content understanding, demafinding content understanding from other members, expressing the need to share content understanding	“Now like it makes sense”, “This is confusing”, “Can you explain? Because I did not get it”, “I think we’ve reached them pretty well”, “Are we OK with these?”, “Do you see what I mean?”
0.709	Task interests	Showing one’s own interests or lack of interests in doing tasks, requiring other group members’ interests or raising an awareness of shared interests	“I’m excited”, “That’s interesting”, “Yeah can’t wait to play with them already”, “The next one will be interesting”, “That’s why it’s too tedious”
0.724	Task difficulties	Stating one’s own thoughts or feelings about challenges,	“I’m nervous in the same time”, “I feel slightly

	issues, problems related to doing tasks	petrified”, “This is going to be more complicated”, “That can be hard, because I mean, they know it’s part of the numbers”

After those two parts of the content analysis were completed, the IBM SPSS Statistics software was used with the Chi-square test of independence and Kruskall-Wallis H-test to explore possible relationships between collaborative dispositions and students’ content-related individual level activities in the knowledge co-construction process. Similarly, Chi-square test of independence was conducted to discover relationships between collaborative dispositions and task-related individual level activities.

5 Results

5.1 What are the students' general dispositions towards collaborative learning? (RQ1)

Collaborative learning dispositions were divided into three groups: High, Intermediate and Low. Students had low collaborative disposition if their score was 93 or below. If the score ranged from 94 to 104, students were put in the Intermediate collaborative disposition group, and they were assigned to the High collaborative disposition one if they attained 105 or over.

As can be seen in Figure 2, half of students were at the low-level of disposition score (f = 7), while the numbers of students who reached intermediate (f = 4) and high (f = 3) level are 28.6% and 21.4%, respectively (M_{score} = 95.64).

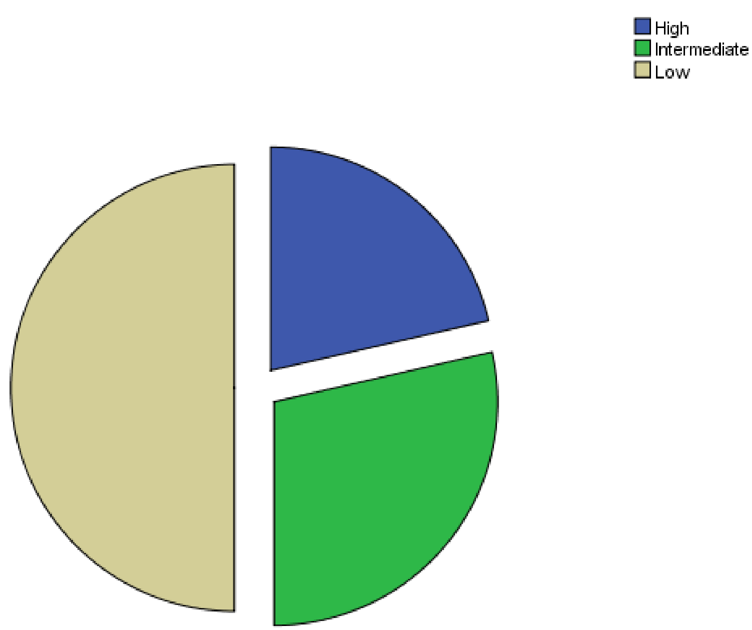

Figure 2. Students' collaborative disposition levels

5.2 How do students participate in knowledge co-construction and monitoring activities in collaborative problem solving? (RQ2)

In general, 1384 activities in both knowledge co-construction and monitoring processes were recorded and classified into sub-categories. Generally, students were more involved in knowledge co-construction processes rather than monitoring ones. Around two-third of recorded activities were recognized as knowledge co-construction (f = 848), while monitoring accounted for one-third (f = 536).

5.2.1 How students participate in knowledge co-construction activities in collaborative problem solving?(RQ 2.1)

The result indicates that there is a significant difference in the type of students' knowledge co-construction activities. During the collaboration process, of the 848 activities of knowledge co-construction, students were more active in sharing information among members (f = 489, 57.67% of all codings counted for knowledge co-construction). Whereas, the least used activity type was making summary, as it accounted for 5.54% (f = 47). Data also shows that students asked more questions (f = 181, 21.34%) than provided answers (f = 131, 15.45%). In terms of asking questions, students mostly produced low-level questions (f = 91, 10.73%), while the number of average- and high-level ones were approximate (f = 44, 5.19% and f = 46, 5.42% respectively). Regarding answering questions, students showed a high frequency of low-level answers (f = 69, 8.14%), while average- (f = 37, 4.36%) and high-level ones (f = 25, 2.95%) were lower (Figure 3).

5.2.2 How students participate in monitoring activities in collaborative problem solving?(RQ 2.2)

Figure 4 illustrates how students monitored the group collaborative learning process. The data shows that around 60% of activities were to monitor how the group has worked (f = 324). The next two noticeable activities were monitoring content understanding (f = 89, 16.6%) and understanding of the task structures, task requirements, task purposes or task instructions (f = 68, 12.69%). Students also expressed their thoughts and feelings about issues faced during solving the task (f = 29, 5.41%) as well as how the task interested them (f = 26, 4.85%).

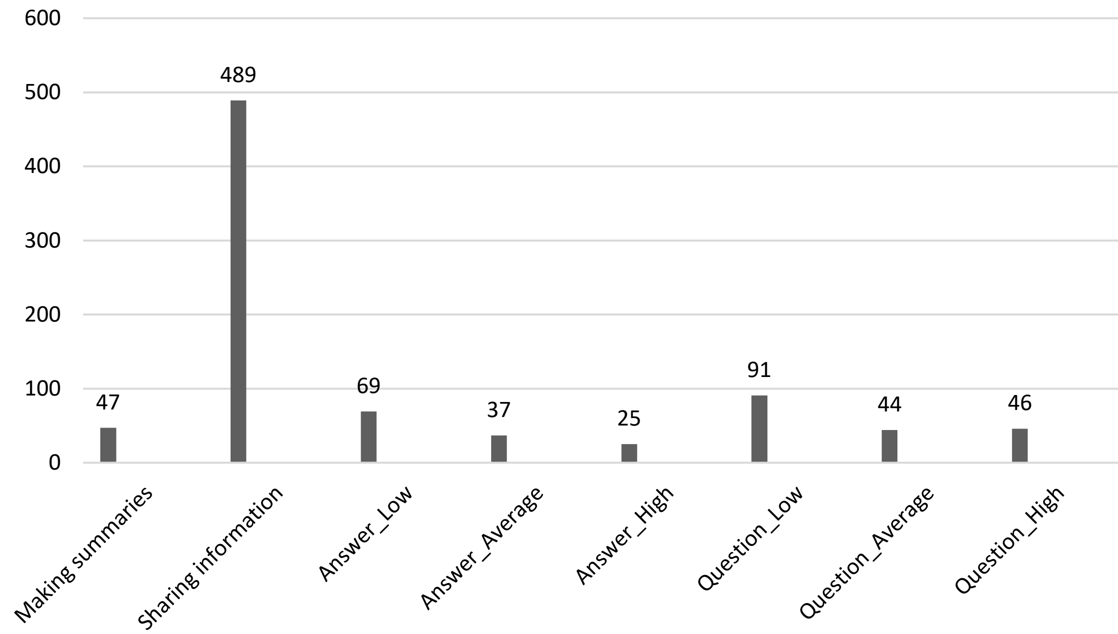

Figure 3. The number of students' knowledge co-construction ac-

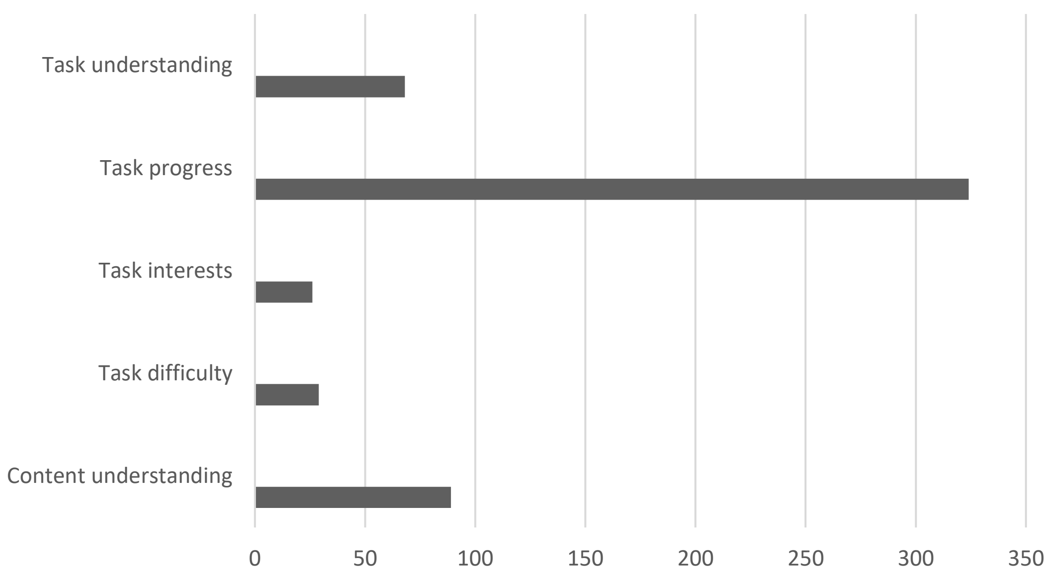

Figure 4. The number of students' monitoring activities

5.3 Do the dispositions of collaborative learning have an effect on how students are participating in collaborative problem solving? (RQ3)

The collaborative disposition scores of individuals and their counted activities in group work were put in the IBM SPSS Statistics software to explore possible relationships between those variables.

5.3.1 Do the dispositions of collaborative learning have an effect on how students are participating in knowledge co-construction processes? (RQ 3.1)

Firstly, the Chi-square test of independence, or the Pearson Chi-square test (McHugh, 2013) was applied. The results show that variables are not significantly associated with each other (p-value > 0.05), meaning that individual level of collaborative dispositions do not influence how actively participants share information, ask questions, produce answers or summarize after discussions (Table 5).

Table 5. Chi-square tests between collaborative disposition and knowledge co-construction activities

	Asymp.Sig. (2-sided)
Disposition level * Making summary	.466
Disposition level * Sharing information	.466
Disposition level * Answer - Low	.330
Disposition level * Answer – Average	.783
Disposition level * Answer – High	.609
Disposition level * Question – Low	.228
Disposition level * Question – Average	.441
Disposition level * Question – High	.348

At this point, it is necessary to invest deeper in the differences between different CPS levels and quality of questions asked and answers provided. Quality of questions and answers can be shown by the number of each sub-level of questions and answers (High – Average – Low).

A Kruskall – Wallis H-test was conducted (Table 6), and it revealed that no significant differences were found between disposition levels and Making summaries (p = .462), Sharing information (p = .245), Answer – Low (p = .546), Answer – Average (p = .355), Answer – High (p = .870), Question – Low (p = .275), Question – Average (p = .079), and Question – High (p = .766).

Table 6. Kruskall – Wallis H-test between CPS scores and Knowledge co-construction activities

Test Statistics[a,b]

	Making summaries	Sharing information	Answer_Low	Anaswer_Average	Answer_High	Question_Low	Question_Average	Question_High
Chi-Square	1.542	2.815	1.211	2.072	.279	2.580	5.082	.532
df	2	2	2	2	2	2	2	2
Asymp. Sig.	.462	.245	.546	.355	.870	.275	.079	.766

a. Kruskal Wallis Test

b. Grouping Variable: Disposition level

5.3.2 Do the dispositions of collaborative learning have an effect on how students are participating in monitoring processes? (RQ 3.2)

Similarly, a Chi – square test of independence was carried out to identify whether students with high CPS scores were more active in monitoring task understanding, task progress, task difficulty, task interest and understanding of content or not. However, the test results revealed no significant association between those variables (p – value > 0.05) (Table 7).

Table 7. Chi-square tests between collaborative disposition and monitoring activities

	Asymp.Sig. (2-sided)
Disposition level * Content understanding	.613
Disposition level * Task difficulty	.507
Disposition level * Task interest	.884
Disposition level * Task progress	.313
Disposition level * Task understanding	.644

5.4 Case study

In the next phase, a case study (Gerring, 2004) of group 6 was taken into consideration. This investigated how students with different collaborative dispositions performed generally differently and how knowledge co-construction and monitoring activities were executed and intertwined.

Group 6 was chosen since there were four students joining, while other groups included only three, or even two. According to Feichtner & Davis (1984), group size had a considerable impact on group work. It was mentioned that groups including fewer than four members could face challenges of lacking resources, while big ones with more than seven participants found it hard to maintain cohesiveness. The second reason to choose group 6 was that they finished all the given tasks in the limited time (1 hour).

5.4.1 Overall performance of group members

Figure 5 illustrates the density of knowledge co-construction and monitoring activities of group 6, where their activities were recorded and shown each minute during 1-hour session. Each color represents a student from left to right of the video (red, green, yellow, blue for student 1 - disposition score: 93, student 2 – disposition score: 81, student 3 – disposition score: 81, and student 4 – disposition score: 114, respectively). The numbers of activities that each student performed in each sub-category, for example, summarizing, sharing information, content understanding or task interest, were shown within the colored circles. Three script phases of orientation, check-up and reflection were marked in the light blue color.

It can be seen from the Figure 5 that in terms of knowledge co-construction activities, students concentrated more on sharing information, ideas, thoughts as well as expressed agreement or disagreement with other members. Regarding monitoring activities, students focused more on monitoring task progress. This was in line with the tendency performed by all 14 students. Besides, during scripted segments at the beginning, in the middle and at the end of learning time, students produced more monitoring activites than knowledge co-construction ones.

Having a closer look at each student's performance, it can be seen that there was a significant difference in contributions among students. Students 1 and 2 were passive throughout the process while students 3 and 4 were more active. If considering student 1 and 2 as passive dyad and the others as active one, a fundamental difference could be found between two groups. Active students showed greater frequency of activities throughout the session (f = 312), while that of passive students were less than a third (f = 85). Additionally, there were some types of activities that weren't observed from student 1 and 2, for example, making summaries or giving high-level answers. On the contrary, a wider variety of activities were demonstrated by the two others (Figure 6 and Figure 7). Another noticeable point was that even though student 3 indicated herself as a low-level collaborative disposition person (CPS score = 81 – Low), she performed as active as student 4, who mentioned himself as a high-level collaborative disposition one (CPS score = 114 – High). There were some collaborative segments where only students 3 and 4 were discussing, without or less participation of other members, for example, around 16'00 to around 21'00, or around 49'00 until the end. Furthermore, even though student 3 and 4 were similarly active, student 3 had more activities in sharing ideas and information than student 4 (f = 85 and f = 55, respectively). Student 4, on the other hand, was more actively monitoring how group work had progressed (f = 49 and f = 26, respectively).

However, knowledge co-construction and monitoring activities were not totally separated but intertwined with each other during the process. As being seen on the density map (Figure 5), in most of the minute time frame, students both built knowledge and monitored that process.

5.4.2 How do students with different collaborative dispositions perform in collaborative problem solving?

During the 1-hour session, students solved twelve exercises from addition, subtraction, multiplication to division, using Montessori blocks and cards. The video shows that active students (student 3 and 4) took the lead in monitoring and moving from one exercise to another ($f_{student\ 3} = 3$, accounting for 20%; $f_{student\ 4} = 12$, accounting for 80%). On the other hand, passive students (student 1 and 2) did not point out that it was necessary to move to the next exercise.

Moreover, in each exercise, students took turns to take the initial step towards discussions, which meant that they actively started the discussion prior to other members. However, again, students 3 and 4 got started more often (f = 4, 33.33% and f = 7, 58.33%), compared to students 1 and 2 (f = 0, 0% and f = 1, 8.34%).

During exercises, group participants experienced the process from unshared knowledge to the built one to find the answers. Students started from sharing ideas, assumptions based on their prior knowledge, while other members actively listened. The flow of ideas were consecutively built until gaps in understanding or conflicts with members' perspectives were detected. When facing issues, they expressed disagreements, questioned contributors, answered or elaborated ideas to bridge the gaps or accept the current shared understanding.

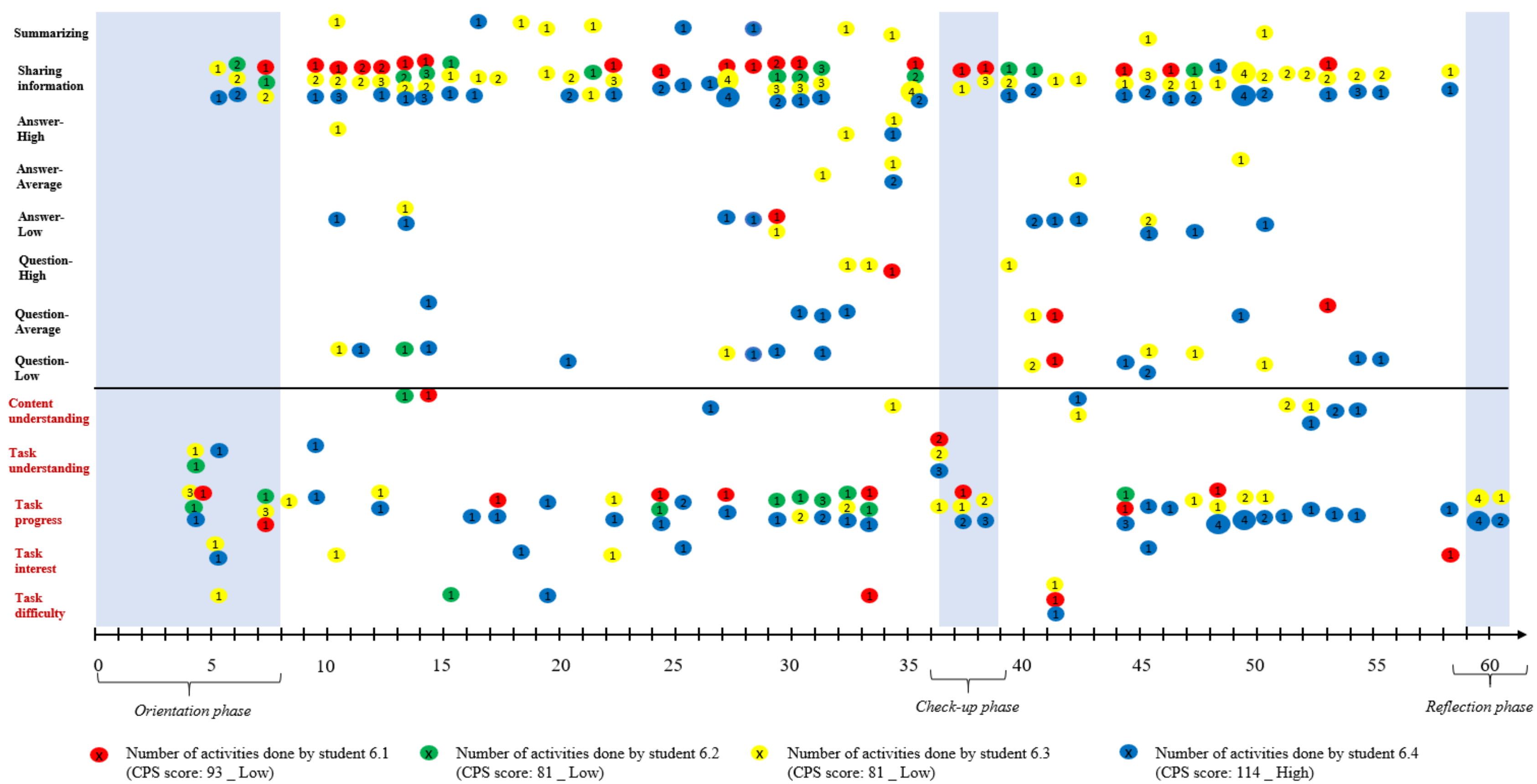

Figure 5. Density of knowledge co-construction and monitoring activities among group 6

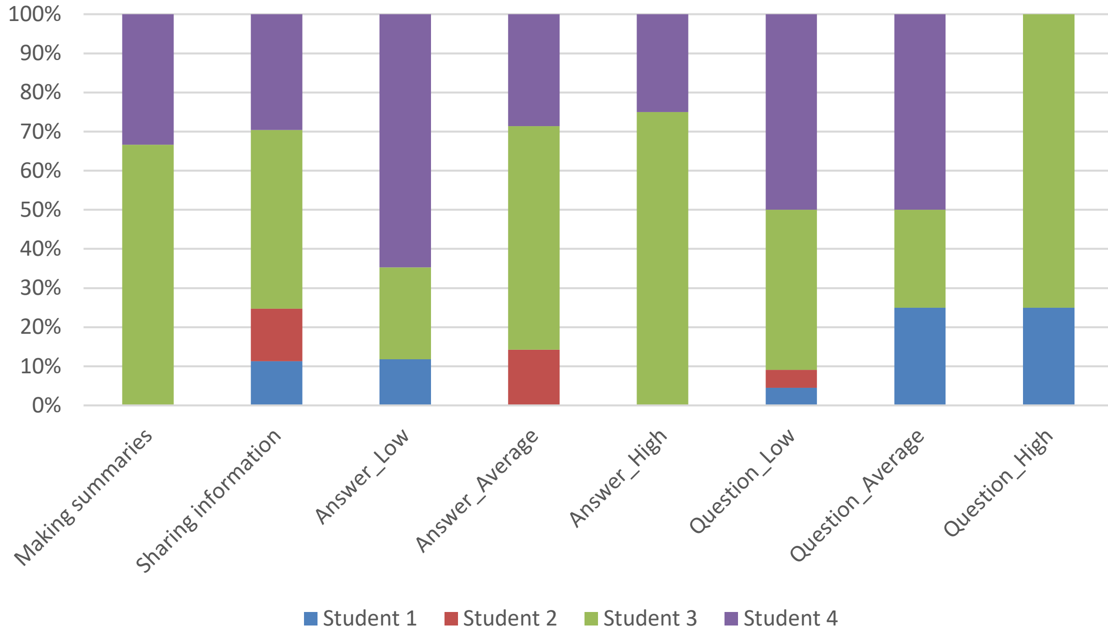

Figure 6. Group 6's activities in knowledge co-construction process

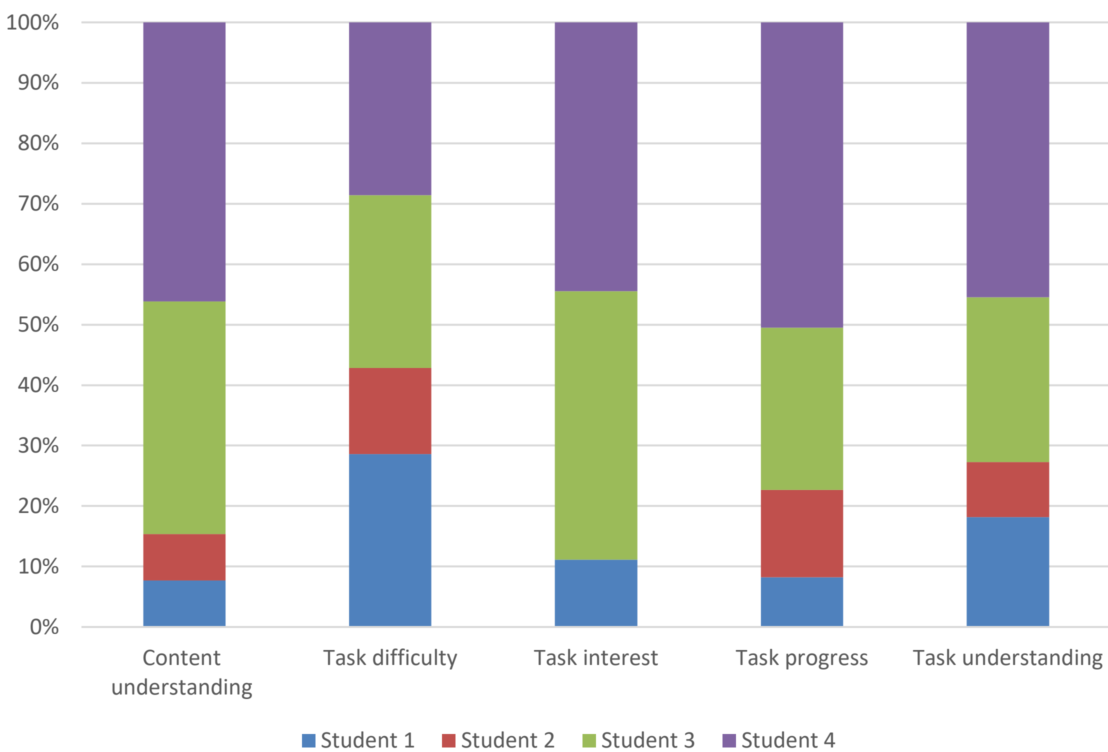

Figure 7. Group 6's activities in monitoring process

Also, monitoring acted as a reminder of group progress to produce appropriate outcomes, triggered further discussions or kept the whole team on the right track (Table 8). This process repeated until the group reached a shared agreement and final answer. However, there were some points that a student's contribution was ignored or stopped (Table 10).

Table 8. Example of how knowledge co-construction and monitoring activities were connected.

Task: subtraction_2000 minus 194

Student	Time	Turn	Transcript	Category
3	29:44 - 29:54	1	2000 – 194. OK, so if we take one from here, we'd have 9 (counting).	Sharing information
4	29:54 - 29:56	2	OK, so this was over here, yeah	Sharing information
3	29:56 - 29:59	3	Yeah, minus 90 from here.	Sharing information
1	29:59 - 30:00	4	So 1... (point to the block)	Sharing information
3	30:01 - 30:02	5	So 1... we just had one there yeah	Sharing information
1	30:02 - 30:03	6	Yeah so 9	Sharing information

3	30:06 - 30:07	7	No no no 1	Sharing information
2	30:08 - 30:10	8	But now we're going the other way.	Task progress
	30:10 - 30:15		Usually we start with the ones with the units and then with the hundreds.	Sharing information
4	30:15 - 30:19	9	Usually start from that side, but… But this way we can't coz there's nothing on that side. 2000.	Sharing information
2	30:20 - 30:25	10	But then you change it at first, like you have… this is 2000...	Sharing information
3	30:38 - 30:42	11	We still going that way, so we just start from here.	Task progress
4	30:42 - 30:45	12	You're not coming from that side, right? Like even if you did what you did, we're still going from this way. Right?	Question_ average
3	30:47 - 30:57	13	So we have to remove 4 from here so 1 2 3 4. So we should have 6 blocks, 6 yellow ones and 9 green ones.	Sharing information
2	31:00 - 31:02	14	But we were subtracting just 4.	Task progress
4	31:03 - 31:05	15	Yeah, just 4… we're just doing the 4	Task progress

2	31:05 - 31:09	16	Yeah, but you have to change it first.	Task progress
...	...	...	...	...
2	31:27 - 31:38	23	Yeah, so I was doing minus 4. So we there's 1996 left and I was going to place this number.	Sharing information
4	31:39 - 31:40	24	Yeah you can do it that way	Sharing information
3	31:41 - 31:43	25	But that's still going from the front to the back.	Sharing information
2	31:44 - 31:48	26	No, not really. We're subtracting 4.	Sharing information Task progress
3	31:49 - 31:50	27	Yeah OK OK OK OK	Sharing information

As can be seen from table 8, active student (student 3) started the discussion (turn 1), followed by the agreement from student 4 (2). Three members shared how many units should be taken from the bigger number. At 30:06 – 30:07, student 3 showed a difference in thinking by stopping the way student 1 arranged the blocks (7). At this point, monitoring progress was applied (8), accompanied by a shared idea (9). After receiving disapproval from students 3 and 4 (11, 12, 13), the group reviewed the process once again. Student 2 suggested the idea once again (16, 23) then found acceptance from student 4 (24). Later, student 3 also accepted the idea (27). At the beginning, after the first trigger for discussion, students consecutively provided ideas based on prior contributions. As can be seen, some disagreements happened, causing hesitation to share ideas from less active students. An identical situation happened to student 1 in another exercise. She was persuaded then agreed with other members' opinions. After checking the answer, others realized the mistake, then student 1 re-explained her initial thought and got accepted by members. Furthermore, transactive discussion was more visible in Table 9, in which students continued each other to reach an agreement. Again, they took care of members' content understanding while explaining (5), or made questions for the contributor when realizing gaps in understanding (9).

On the other hand, table 10 shows how contributions were ignored or incompleted during group work. When an average-level question was raised by student 4 (turn 1), student 1 intended to give an answer (2). However, her contribution was stopped (2) by student 3 (3), who was more active during the whole working process. Later, the question about how teachers can explain subtraction procedures to students was still discussed. At 34:00 – 34:01, student 4 explained, but the explanation was incomplete (9) when student 3 interrupted to elaborate on student 4's saying (10). Similar activities could be found in turn 12 and 13.

Table 9. Example of transactive discussion

Task: addition

Student	Time	Turn	Transcript	Category
2	13:41 - 13:43	1	Is there a rule how you have to place it here?	Question_ Low
3	13:44 - 13:44	2	No	Answer_ Low
4	13:44 - 13:45	3	I do not think so.	Answer_ Low

2	13:50 - 13:58	4	Because if you have them like this, you added them, you can't really see that it's more than 10... more than 9, so you have to change this. Do you know what I mean?	Sharing information Content understanding
1	14:04 - 14:04	5	No	Content understanding
2	14:04 - 14:14	6	OK so if you add this now and you just put it all together. You do not see that this is more than 9. You can't see this.	Sharing information
1	14:14 - 14:15	7	You count them	Sharing information
3	14:18 - 14:21	8	Yeah, 'cause the point of the counting blocks is to count each block.	Sharing information
4	14:21 - 14:26	9	But even if you do it that way, could you identify it right away that it's more than nine? You have to stop and count it.	Question_ Average Sharing information
2	14:26 - 14:28	10	At least it fits in here.	Sharing information
4	14:32 - 14:38	11	Now they thought of that too, so that's ten exactly right? So you know if it's over 10. Yeah, that's a good point	Question_ Low Sharing information

Table 10. Example of how contributions were interrupted or ignored

Task: subtraction_2000 minus 194

Student	Time	Turn	Transcript	Category
4	32:54 - 32:56	1	What's the rule with crossing with zeros? I do not remember.	Question_ Average
1	32:56 - 32:57	2	You put 10...	Sharing information
3	32:58 - 33:23	3	You put 10, borrow 9, 10 borrow 9, till you need it. So you did like this... so 2000 minus 194. So kind of 10 borrow that one left. You've got 10 borrow 9 in their bottom line here. 10 - 4 = 6... 9 - 9 = 0... 9 – 1 = 8.	Answer_ High
...	...	...	...	...
4	34:00 - 34:01	9	I can explain... that we took out the 4 first...	Answer_ Average
3	34:02 - 34:04	10	And then got them from this	Answer_ Average
1	34:05 - 34:09	11	what I mean like how you can take?	Question_ High
4	34:14 - 34:18	12	But I think you can make it visually 'cause you have these squares you want to take out 4...	Answer_ Average
3	34:18 - 34:31	13	One red one and making it blue and green and yellow at the same time. But yeah, 'cause we would take six out and you would have 904…	Answer_ Average

6 Discussion

This study investigated how students performed in knowledge co-construction and monitoring activities in collaborative learning. After that, the relationship between collaborative dispositions and students' contributions in group work was discovered. To sum up, half of students in this research were at a low level of disposition, while approximately one-fourth was at intermediate and another one-fourth was at high level. During collaboration, students focused on knowledge co-construction more than monitoring tasks' related elements, content understanding, task interests or difficulties. When taking a closer look at each procedure, the data reveals that participants spent more time on sharing information and monitoring what had been done as well as what should be done next. Unexpectedly, there was no correlation found between disposition levels and individual contributions. Even though students' disposition scores did not affect how they contributed to the group outcomes, when analyzing the case study, still, there were variations among the students who achieved different scores in ways and amount of participation in group activities.

Furthermore, the micro-analysis of the case study revealed that active students (student 3 and 4) frequently triggered the discussions at the beginning of exercises; also, they monitored when the current exercise finished then led the group to the next one. Besides, active students had a wider variety and higher levels of knowledge co-construction and monitoring activities, compared to passive students (student 1 and 2). Particularly, passive students did not make summaries after discussions or provide answers with detailed explanation.

While discussing to find answers for each exercise, members went through the knowledge co-construction process, including three forms of external knowledge, shared knowledge and common ground, via four processes (externalization, internalization, negotiation and integration), which were similar as found in Beers et al. (2005) study. During this, students took turns to build up the solutions. They expressed approval, disapproval, provided feedback, etc. based on preceding contributions. These indicated productive interactions in which learners exchanged knowledge and views to generate knowledge and achieve joint understanding (Shukor et al., 2014; Barron, 2000).

However, active students displayed a higher frequency in elaborating responses or giving transactive sharings. Another distinguishing feature among members was that information or ideas shared by active students were frequently thorough, including elaboration, while ones produced by less active learners were often shorter and stopped at sharing without detailed explanation.

Besides, even though most of the questions asked were low-level ones, they were produced mostly by active students, who also performed thought-provoking questions. Questions played significant roles in both cognition and metacognition processes. High-level ones activated prior knowledge, combined with the current learning situation to foster thoughts and consider learning and teaching scenes that could happen. For example, high-level questions made members think how the pieces of exercise can be used to teach future students, how to simplify the concepts to help them understand easier, or if there was another way to carry out exercises. Average- and low- level questions were used in cognitive processes, seeking information to continue group discussions or bridge gaps in shared understanding. On the other hand, questions relating to monitoring were to check if all members were on the same page, or what progress the group should take.

This confirmed findings from previous researchers about cognitive and social duties of questions (Graesser & Person, 1994). It was concluded that asking questions could solve students' knowledge deficiency when they detected contradictions that are against their prior knowledge. Also, it was possible to help learners monitor their knowledge, for instance, when they defined strange words while discussing or other unusual facts (Graesser & Person, 1994). Additionally, in that same research, it was found that good students required more detailed, deeper answers and explanations on a more complicated level. Thus, they produced more high-level questions. This brought insights into differences in asking questions among active and passive students in this study.

Furthermore, active members were the ones sharing answers for most of the questions produced or making summaries at the end of tasks. When learners questioned, justified, answered, provided elaboration, summarized, they were discussing at a high-level cognitive involvement (Howard, 1996; Näykki, Järvelä, Kirschner, & Järvenoja, 2014). In contrast, passive participants communicated less and had a low rate of questioning, answering, explaining and summarizing. A similar conclusion was indicated by Tejeda and Dominguez (2019) where the researcher found that productive and successful students actively listened to their peers' sharings, provided meaningful explanation, showed engagement throughout discussions, examined learning procedures, and had interests in attaining implementation.

In addition, Tejeda et al., (2019) figured out that some unproductive students faced challenges in communication. Despite producing right answers or knowing discussed concepts, they did not have absolute confidence to present ideas or elaborate on peers' contributions. This could be seen clearly also from student 1 and 2 in this case study.

Furthermore, though members had transactive discussions, there were moments when contributions were ignored or interrupted. The interruption was mostly caused by active members, meaning passive ones were stopped or forgotten while talking. In Barron (2003)'s research, actions lacking joint attention, rejecting or ignoring preceding contributions could inhibit learning opportunities.

Additionally, participants' monitoring activities prompted further discussions, questions, answers as well as reminded members when they were off track. They monitored not only their own but also other group members' understanding of content or task-related information as well as awareness of task progress. The research shows that learners were busy monitoring progress of tasks rather than other kinds of monitoring. The finding aligned with Janssen, Erkens, Kirschner and Kanselaar (2012), in which the authors stressed that task progress activities were conducted regularly by students.

Interestingly, members who were active in knowledge co-construction were also active in monitoring their learning process. Analyzing group 6 working process revealed that monitoring and building knowledge activities weren't separated but intertwined. Knowledge co-construction activities themselves are insufficient for successful group outcomes, and need to engage task-related regulation (Van der Meijden & Veenman, 2005). Metacognition during performing tasks are necessary and important to attain successful collaboration (de Jong, Kollöffel, van der Meijden, Staarman, & Janssen, 2005). These results confirmed findings of Jahn and Shah (1997), indicating that task monitoring and group cognitive processes were related to each other. Indeed, a person cannot have metacognitive knowledge about one's own competencies if one does not possess considerable cognitive knowledge (Veenman, Van Hout-Wolters, & Afflerbach, 2006). On the other hand, cognitive activities are influenced by metacognition, for instance, planning strategic steps for current tasks based on prior experience. Thus, cognition and metacognition are related and hard to disentangle (Veenman et al., 2006).

In terms of unmatchable connection between collaborative dispositions and collaborative problem solving performance, two reasons were involved. First, the way students evaluated themselves in the survey of collaborative disposition was not absolutely correct. Indeed, Wu and colleagues (2013) stated that dispositions supporting collaboration, for instance, commitment, interactive contribution, constant adjustment or inclusive cooperation, derive from a person' conviction such as self-efficacy. However, self-efficacy is individuals' estimation that when some sorts of action are implemented, expected results are achieved (Bandura, 1977). Similarly, Schussler (2006) argued that dispositions operate based on self-awareness, inclination, and reflection. While self-awareness relies totally on personal perspectives, inclination also indicates feelings to carry on a particular behavior, and reflection, in collaborative context, involves recognition and analysis of skills and surrounding context. Hence, these mean that outcomes in reality can be different from predicted ones, and students' belief about their collaboration can be dissimilar to their actual behaviors during the collaborative process.

The second reason could come from the way interaction and sharing activities happened during group work. As being said, some students faced communication problems that hindered them from sharing ideas or having feedback on group members' contributions. Also, they were easily stopped from exchanging their thoughts by others. Those elements discouraged students from contributing as what they expected themselves to do. On the other hand, Nokes-Malach, Richey and Gadgil (2015) collected other reasons causing failure in collaborative learning process, regarding cognitive and social factors, and those can be explanations of students' behaviors in this case study. For instance, *retrieval strategy disruption* means that group members can experience failure when they fail to follow their train of thought while focusing on other members (Finlay, Hitch, & Meudell, 2000). In addition, *social loafing* indicates that participants do not fully join in solving the task because they believe that someone else in the group will take the responsibility (Karau & Williams, 1993). On the contrary, elements for successful collaboration were also invested in that same study. However, investing more in those reasons as well as how collaborative dispositions enhance positive factors or reduce negative factors are beyond the scope of this study.

7 Conclusion

The study aimed to explore students' collaborative disposition, how individuals performed variously during collaborative problem solving as well as how collaborative disposition was related to individual performance in group work.

First, in collaborative problem solving context, collaborative disposition contains teacher students' attitude towards cooperative mindset, negotiation and team leadership. Particularly, cooperative mindset means students' beliefs and viewpoints about motivation to work in a team, and outcomes achieved such as better decisions or higher efficiency. Negotiation is how a person enjoys being a good listener, considering other members' interests, being flexible and open with diverse perspectives or having positive feelings seeing their peers successful. Last but not least, learners with high disposition in team leadership are the ones showing their willingness to take responsibility, share thoughts, convince other members with their opinions or assist and bring the team together.

Second, in the procedure of collaborative working, students spent more time and effort on knowledge co-construction activities, especially sharing thoughts, ideas, showing agreement or disagreement with other group partners' sharings. Besides, regarding monitoring activities, learners monitored group task progress the most. They not only monitored their own but also members' progress of what and how they had done the task and suggested the next steps.

Third, it was concluded that there was no significant relationship between collaborative disposition levels and individual performance. This means that students can state their collaboration capacity, collaboration beliefs or viewpoints in a way that does not match what they produced in group tasks. However, there were some differences between those groups of students found in the case study regarding frequency and level of activities.

The study contributes to the previous research by confirming characteristics distinguishing high-performing students and lower-performing ones. Also, this study considers collaborative problem solving from the individual side, discussing how students evaluated their collaboration skills themselves and showed those in group work. The findings reveal that students who were active in knowledge co-construction also activated their monitoring skills. This is caused by interconnections between knowledge co-construction and monitoring. In terms of teaching practices, the study confirms that dispositions in general and collaborative dispositions in particular are needed for teacher training programs, and this prepares teacher students' mindset as well as encourages them to sharpen their collaborative learning skills. Also, there is an essential necessity to develop students' knowledge co-construction and monitoring competency, regardless of their collaborative disposition scores.

7.1 Limitations

This research has some limitations. First, it can be seen that the sample size is small. The small data collection of 14 students hindered finding exact correlations between collaborative disposition levels and students' performance. Also, statistics from disposition sub-items (cooperative mindset, team leadership and negotiation) are missing, leading to unclear disposition tendency among students. Thus, a larger number of students with figures of each sub-item in disposition can help generalize how dispositions influence students' activities.

Second, the data set did not include information about students' Mathematical competence, which could be measured by pre- and post-test. Mathematical skills can influence students' confidence in solving the tasks, hence, lack of tests may affect explanations about the unparalleled relationship between collaborative dispositions and students' performance in groups.

Third, video interpretation may contain some misunderstandings. Even though the data analysis is based on clear coding schemes, and the analysis reliability were checked to ensure that the author understood and interpreted videos correctly, there is a potential that some moments go unnoticed or misunderstood.

7.2 Implications and future research

The present study unveiled collaborative problem solving from an individual-level aspect instead of group-level one. In future research, different disposition traits could be studied with more details and included statistics of sub-categories such as cooperative mindset, team leadership or negotiation. Besides, disposition represents internal features, but evaluation is conducted based on shown outcomes (Schussler, 2006). Thus, different methods to evaluate and assess dispositions should be developed to have a more general and complete understanding of collaborative dispositions. Additionally, it is necessary that more videos of collaborative problem solving processes are collected and analyzed, together with more case studies that are investigated deeply. Hence, if a similar study is conducted with a larger collection of data, it is possible to identify explicitly what students perform variously during the working process. Also, it enables findings of what specific disposition traits have the most influence on individual performance.

In the context of teacher education, embedding teacher dispositions in general and collaborative disposition in particular in training programs is as essential as teaching and evaluating knowledge and performance (Wayda & Lund, 2005). They should be motivated to not only achieve knowledge and skills demanded for teaching, but also formulate necessary awareness, inclination and reflection capacity in teaching (Katz & Raths, 1985). In order to do that, dispositions rubric need to be developed (Wayda & Lund, 2005). Besides, practical training activities should be built in an organized pathway that gradually supports teacher students.

In the context of collaborative learning, it is necessary to train and enhance knowledge construction and monitoring skills. For example, as mentioned, asking questions is an essential skill due to its potential to prompt cognition such as reasoning, or to monitor group working procedures. High-level questions requiring deep understanding and clear clarification are capable of enhancing collaborative discussions and learning outcomes (Graesser & Person, 1994; King, 1999). Thus, training students how to ask good questions is important. Similarly, supporting learners' monitoring skills should be considered, as it was proved that monitoring intertwined and played a crucial role during cognitive processes. When collaborative dispositions and collaborative learning are successfully embedded in teacher training programs, teacher students are able to place positive effects on their future students by creating meaningful knowledge building learning environments and enjoyable collaboration among students.

The current study paves the way to utilize disposition scores to roughly predict students' performance in team work. This may lead to pedagogical teaching methods in which students are grouped, based on their disposition scores, to form an effective team where each student is able to share and learn from their group partners. At that point, learners benefit more from collaboration as well as enjoy meaningful team working. However, in order to reach that practical purpose, the findings from this study recommend a necessity to identify levels of disposition again beside questionnaires; thus, educators have accurate evaluation of students' disposition. Moreover, the study suggests providing support to low-level disposition students before group work, so that they gain strong confidence in themselves and have higher skills in knowledge co-construction and monitoring.

8 Evaluation

This research studied how students participate in collaborative learning when they possess different collaborative disposition levels. Questionnaires and video data were collected from the PREP 21 project (Prepare teacher students for the 21^{st} century learning practices), and 14 students were from the University of Oulu. When data is collected in the form of video, it is possible to retrieve, re-watch permanently and help other researchers to check findings, which benefits reinterpretation (Plowman, 1999). In order to analyze video data, the researcher combined coding schemes from Vuopala et al. (2019), Näykki, Järvenoja, et al. (2017) and Shukor et al. (2014).

8.1 Validity and reliability

Validity is crucial for effective research; thus, it is required for both quantitative and qualitative research. Validity is an indication that a particular instrument is responsible for successful measurement of what it is expected to measure (Cohen, Manion, & Morrison, 2002). In other words, there is a need to consider if the measurement method is able to accurately measure what they are intended to measure (Golafshani, 2003).

In this study, theoretical construction was built to serve the research questions, explain researched phenomena; thus, it covered main related concepts of collaborative learning and collaborative dispositions (*Theoretical validity,* Maxwell (1992)). Moreover, when all theoretical background was mentioned, and data was analyzed, there were comparisons of this research's findings and previous ones from other studies. Additionally, evaluation and critical perspectives were built to show researcher's own judgement and opinion (*Evaluative validity,* Maxwell (1992)).

Furthermore, internal validity considers accuracy of data explanation (Cohen et al., 2002). This aims to generate a clear explanation of a particular event or issue by the data provided. In order to ensure internal validity, the research involved another researcher who had the same educational background knowledge, using video data that could be stored and retrieved.

In terms of reliability, as the built coding schemes contained various categories, it is necessary that analyses were carried out multiple times to make sure that interpretations were correct. In addition, inter-rater reliability was rechecked. After analyzing the videos, 20% of the total amount of data was observed and interpreted by another researcher who had similar background knowledge and understood the coding schemes. Cohen's Kappa statistics showed moderate and substantial agreements between two researchers. This was conducted to reduce potential bias that could have occurred during the interpretation phase.

8.2 Ethical issues

First, this study used the reference technique of APA 6th – No Title Casing Applied – American Psychological Association, 6th Edition. While building theoretical framework, discussion as well as any other parts that need collecting information from previous studies, this reference style was used to avoid plagiarism. Furthermore, this acknowledged authors and originality of previous studies.

The questionnaires and videos were collected in the PREP21 project under permissions of heads of departments and willingness of participants. Data was observed for research purposes only and would not be shared in public space or stored in any cloud service or equipment. Furthermore, participants' names were replaced by numbers, for example, student 1, student 2.

Regarding research processes, steps and procedures were described completely, and then findings were reported thoroughly, based on what data illustrated in the analyzing steps.

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Appendix 1. CPS questions

The following questions are about issues related to collaboration and ways of working. Answer according to how you agree or disagree. Choose one option on each row.

1 = I completely disagree

2 = I mostly disagree

3 = I partly disagree

4 = I do not agree or disagree

5 = I partly agree

6 = I mostly agree

7 = I completely agree

I prefer working in a group rather than working alone.

1 2 3 4 5 6 7

I am a good listener.

1 2 3 4 5 6 7

I enjoy seeing my peers succeed.

1 2 3 4 5 6 7

I gladly take responsibility of groups or projects.

1 2 3 4 5 6 7

I enjoy sharing ideas.

1 2 3 4 5 6 7

I can convince others and make them see my point of view.

1 2 3 4 5 6 7

I enjoy exchanging thoughts.

1 2 3 4 5 6 7

I take others' interests into consideration.

1 2 3 4 5 6 7

I believe groups make better decisions than individuals.

1 2 3 4 5 6 7

I like convincing other students.

1 2 3 4 5 6 7

I like forming a group.

1 2 3 4 5 6 7

I enjoy thinking about different points of view.

1 2 3 4 5 6 7

I believe that group work improves my efficiency.

1 2 3 4 5 6 7

I enjoy collaborating with other students.

1 2 3 4 5 6 7

I am open to all sorts of opinions.

1 2 3 4 5 6 7

I like to give feedback.

1 2 3 4 5 6 7

I am flexible when I work in a group.

1 2 3 4 5 6 7

I enjoy an assisting role in a group.

1 2 3 4 5 6 7