How Does the Quality of Planning Contribute to Group Performance and Challenge Perceptions under Three Computer-Supported Collaborative Learning (CSCL) Conditions

by

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Supervisory Committee

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Abstract

Students often struggle with collaboration. Successful collaboration requires planning which is often neglected by individuals and groups. Research about whether technological interventions impact online collaborative processes and how these interventions take effect is limited. During the COVID-19 pandemic research about how to support effective online collaborative learning has never been as important for guiding best practices in post-secondary learning contexts.

The aim of this qualitative case study was to explore how the quality of planning discussions contribute to group performance and planning challenge perceptions, under the three different planning support conditions. Specifically, the study compared the planning interactions among groups who (a) reported different planning challenge experiences, (b) received different kinds of planning support, and (c) achieved different learning outcomes (group performance). Participants were drawn from 180 undergraduate students enrolled in a first-year course in a university in Canada. Students used an online chat tool to complete a collaborative task and reflect on the process. Extreme case sampling was used to identify groups who perceived planning as problematic (6 groups) and groups who did not (6 groups). Chat transcripts were analyzed for quality and characteristics of groups' planning discussions. Findings indicate (a) planning was largely neglected by groups, (b) the overall quality of groups' planning discussions were not calibrated with groups' perceptions of planning challenges encountered by the group, (c) groups who received the planning support in the form of nominal visualizations engaged in more powerful planning processes during collaboration, and (d) group performance on the task differed between groups who perceived planning problematic and groups who did not. This study contributes to the field by recognizing the deficiency of groups' planning process in

collaboration and providing evidence of the effectiveness of a planning support tool. Recommendations for incorporating collaboration into online learning and instruction during COVID-19 are presented in the conclusion.

Key words: Planning Support, collaborative learning, planning discussions

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Chapter 1: Introduction

Collaboration has been increasingly recognized as one of the essential workplace skills as well as a critical competency in the 21st century

(Employment and Social Development Canada, 2015). Post-secondary institutions have a responsibility to help young adults develop the ability to collaborate effectively in diverse groups (Binkley et al., 2012). For example, '*collaboration and the ability to work in teams*' was identified by the University of Victoria as an important learning outcome (University of Victoria Calendar, 2019-2020, p596). Collaborative learning focuses on constructing knowledge rather than making products or completing tasks. More importantly, the COVID-19 pandemic has posted unprecedented challenges to all kinds of educational scenarios. Academic activities which were previously occurred face-to-face have been disrupted due to university closure and physical distancing. It is essential and urgent for educators to ensure that collaboration could still successfully happen when learning processes have been largely moved to online platforms and text-based forms of collaboration (e.g., Teams chat, chat tools in Zoom) have become a necessity.

However, research findings suggest simply gathering a group of students and giving them a task, whether online or offline, does not guarantee successful collaborative learning (Dillenbourg, Järvelä, & Fischer, 2009; Järvelä & Hadwin, 2013). Furthermore, the online environment introduces additional challenges to group productivity as students can be easily pulled away from learning activities by distractions such as social media alerts when they are along with their devices (Anderson et al., 2014). Active regulation in collaborative learning at both individual level and group level are necessary, and effective tools are needed to facilitate

these regulations in collaborative learning (Dillenbourg et al., 2009; Hadwin, Järvelä, & Miller, 2011, 2018; Winne, Hadwin, Perry, 2013).

In response, studies on computer-supported collaborative learning (CSCL) over the past two decades mainly focused on two issues: (a) situations in which students can learn together in effective ways, and (b) technological tools that can be used to facilitate productive collaboration (Dewiyanti, Brand-Gruwel, Jochems, & Broers, 2007; Dillenbourg et al., 2009). Research has examined two types of technological tools that are designed to support students' collaboration: (a) scripting tools that provide direct guidance to students in collaboration, and (b) group awareness tools that indirectly help students take control of their collaboration process (Dillenbourg, 2002; Janssen & Bodemer, 2013; Järvelä & Hadwin, 2013; Miller & Hadwin, 2015a).

Planning, as the foundation of successful regulation of learning processes, has been found to be essential for collaborative learning, yet it is largely neglected by students working in groups (e.g., Hadwin, 2017). Two kinds of support tools have been developed to promote planning in collaborative learning: (a) planning scripts that provide direct guide to individuals and groups about planning and the big picture of the task, and (b) group awareness tools in the form of visualizations that provide graphical results of group members' response about planning issues. Research has found that students report planning as less problematic when planning support tools are provided during collaboration (e.g., Hadwin, Bakhtiar, & Miller, 2018).

Educators have called for research to examine the effectiveness of these tools for facilitating collaboration processes, especially under the circumstances where interactional practices are embedded in classroom practices (Barron, 2003). Recent studies responded to the call have found that planning support in the form of visualizations has an impact on individual

perceptions of planning challenges, yet how exactly these visualizations change the perceptions of planning in collaboration remains unclear.

Chapter 2: Theoretical Framework

Self-regulated Learning

Theories of regulation for collaboration have been developed based on self-regulated learning (SRL) theories. Early research found that self-regulated learners actively search for information when needed and take actions when they encounter challenges during learning processes (Zimmerman, 1990). In the past 30 years, SRL models have been developed with different emphases such as the roles of goal and emotion regulation (e.g., Boekaerts, 1992; 1996), motivation (e.g., Pintrich & Groot, 1990), metacognition (e.g., Efklides, 2011; Winne & Hadwin, 1998, 2008), and the social and interactive features of learning (e.g., Hadwin, Järvelä, & Miller, 2011; 2018). Among these SRL models, Winne and Hadwin's model (1998, 2008) indicates that self-regulated learners consciously take control of their learning across four recursive and iterative phases including (a) task understanding: students generate an understanding of the task to be performed, (b) goal-setting: students develop their goals and make plans to achieve them, (c) tactics/strategies enacting: students intend to use tactics and strategies to achieve their goals, and (d) adapting: students decide to make long-term changes for learning in the future.

This proposed study draws from Winne and Hadwin's SRL model for several reasons. First, the model separates planning into two phases: task understanding and goal setting. It recognizes the necessity of interpreting task content, objectives, and requirements and their essential role in collaboration and collaborative learning. Second, it recognizes the social and contextual nature of regulation as one of its key features. Regulated learning happens in social activities, and it is important to consider the social context and dynamic interactions (in both individual learning and group learning) occurring within these systems (Hadwin et al, 2011;

2018; Hadwin & Oshige, 2011). Third, Winne and Hadwin (1998, 2008) also identified COPES (named by using the first letter of the five constructs: Conditions, Operations, Products, Evaluations, and Standards), as a central mechanism underlying regulation processes within each phase of self-regulated learning. The COPES model can be useful when investigating the relationships among variables. Lastly, this model has been extended as a framework for describing multiple forms of regulation in collaboration: self-regulated learning (SRL), co-regulated learning (Co-RL), and socially shared regulation of learning (SSRL; Hadwin et al., 2011, 2018).

Regulation of Collaborative Learning

Collaborative learning happens through social interactions. Early conceptions of self-regulation created a foundation for exploring social modes of regulation conducted in collaborative contexts (e.g., Hadwin et al., 2011; 2018; Järvelä, Järvenoja, & Veermans, 2008). Over the past two decades, Hadwin and colleagues extended the SRL theory and model (Winne & Hadwin, 1998; 2008) to consider three modes of regulation within a group context: self-regulation, socially-shared regulation, and co-regulation (Hadwin et al., 2011; 2018; Hadwin & Oshige, 2011; Järvelä & Hadwin, 2013; Miller & Hadwin, 2015a).

Self-regulated learning (SRL) refers to individual learners' metacognitive control of their cognition, behaviour, motivation, and emotions through iterative processes of planning, task enactment, reflection, and adaption (Hadwin et al., 2018; Winne & Hadwin, 1998), *socially shared regulation of learning* (SSRL) refers to groups' metacognitive control of their co-constructed cognition, behaviour, motivation, and emotions through interactions and negotiation on planning, task enactment, reflection, and adaption (Hadwin et al., 2018). *Co-regulated learning* (Co-RL) refers to the dynamic metacognitive processes through which self-regulation

and socially shared regulation of cognition, behaviour, motivation, and emotions can be stimulated or impeded (Hadwin et al., 2018).

Research has made it clear that the three forms of regulation (self-, co-, and socially shared regulation of learning) are critical for collaboration (e.g., Hadwin et al., 2018; Järvelä & Hadwin, 2013; Panadero & Järvelä, 2015). In terms of self-regulated learning, individual learners in groups also need to activate their own task understandings, goals and strategies that may or may not be aligned with their groups' task understandings, goals, and strategies. Although a direct correlation between self-regulation and group performance has not been found, research indicates that groups with better self-regulators often show higher levels of group regulation (Hadwin et al., 2018; Panadero, Kirschner, Järvelä, Malmberg, & Järvenoja, 2015). Socially shared regulation has been considered critical for success. Evidence indicates that groups showing high-level SSRL tended to be those with higher performance (Janssen, Erkens, Kirschner, & Kanselaar, 2012; Volet, Summers, & Thurman, 2009). Co-regulation, which plays its role in affording and constraining self- and shared regulation, was recently found to be associated with group climate in collaborative tasks (Bakhtiar & Hadwin, 2020).

To achieve collaboration success, individuals and groups need to engage in the three forms of regulation to metacognitively control their own, others, and the groups' motivation, cognition, and behaviors, through which shared task understandings, shared goals, and shared strategies are co-constructed. However, groups may struggle at the very beginning of collaboration when shared task understanding and goals are supposed to be co-constructed.

Planning and Its Challenges in Collaboration

Planning includes two phases of SRL: (a) task understanding (task perception), interpreting task requirements, purposes, and context based on one's previous experiences, past

performance, and cognitive level, and (b) goal setting, translating task understanding into goals and plans that can guide efforts and actions to achieve the goals and plans (Winne & Hadwin, 1998). In individual learning, well-developed task understanding enables learners to establish the information and resources needed to generate goals and plans for achieving learning outcomes. Research found that the quality of learners' task understandings and plans are largely related to learning outcomes, such us academic performance (e.g., Butler & Cartier, 2004; Greene, Hutchison, Costa, & Crompton, 2012; Jamieson-Noel, 2005).

Planning in collaborative learning is also critical. During collaboration, group members align their task understanding and task goals, and these two components pave the way for the task and later becomes the foundation of strategic action and metacognitive control (Winne et al., 2013). In other words, during teamwork, group members need to negotiate their personal understanding and goals to co-construct all-agreed plans, goals, standards, and regulatory strategies to guide them to successful collaboration (Hadwin et al., 2011; 2018).

Research consistently indicates that group planning is associated with learning results. Early in the last century, studies have found that planning can improve group performance as well as group members' motivation level (e.g., Bryan & Locke, 1967; Stout, Cannon-Bowers, Salas, & Milanovich, 1999; Weingart, 1992; Weingart & Weldon, 1991;). Recent research, focusing on shared task understanding and collective goals, also indicates that when groups are facing problems with planning, their regulation and task performance can be influenced (Miller & Hadwin, 2015a).

However, the critical role of planning is often neglected in groups. Group members tend to skip the planning step and prematurely proceed onto the task enacting phase (Hadwin, 2017). As a result, groups often report high-level challenges in planning (e.g., Bakhtiar et al., 2018;

Barron, 2003). Furthermore, when groups engage in little conversation about task perceptions and group plans, they often end up with more than one person working on the same resource and are unable to complete the task on time (Rogat & Linnenbrink-Garcia, 2011). Unfortunately, these difficulties lead to later reports of challenges with task enacting (Bakhtiar et al., 2018). Thus, extra supports are necessary to facilitate planning in collaboration.

Planning within the COPES Model

Winne and Hadwin (1998, 2008) also described the mechanism of regulation process in each phase of self-regulated learning using a cognitive architecture: the COPES model. This model was named by using the first letter of its five constructs: conditions, operations, products, evaluations, and standards. Conditions were defined as internal (e.g., learner's motivations and beliefs, previous knowledge, attitude towards the task) or external (e.g., physical environments, course settings, prompts from other learners or instructors) environments of learners. Operations refers to learners' actions performed during the learning processes; according to the SMART (Winne, 2001) model, these actions include searching, monitoring, assembling, rehearsing, and translating information. Products refers to the outcomes (e.g., perceptions, completed works or results) that produced by learners through operations performed in learning. Evaluations are learners' judgement about their learning processes and learning outcomes. And lastly, standards refer to learners' criteria of how learning processes as well as learning outcomes should be like at the end of session. Considering collaborative learning in groups, Miller and Hadwin (2015) divided the construct of *conditions* into three categories: self (my understandings about me), task and context (my understanding about other group members and physical environments), and group (my understanding about our group)

The five constructs are intertwined with each other during learning processes within each phase of self-regulated learning. The internal and external conditions directly inform learners' operations, and meanwhile, affect learners' perceived standards of how their learning products should be like at the end of a learning phase. Through learning operations, products are generated and also evaluated by learners based on their standards. Lastly, the evaluation of products can in turn affect individuals' learning conditions.

Planning also fits in this model (see Table 1). During planning, external conditions (e.g., instructors' prompts about the task, course material like syllabus or textbook, environmental distractions) and internal conditions (e.g., learners' previous knowledge about the course or the task, commitment to the task, preparations for the task) inform and affect individuals' operations and perceived criteria of what planning can produce (i.e., *what I think of our task perceptions, our goals and our plans*). After individuals' evaluation of their products, conditions (both internal and external) change and the new conditions again affect the following operations and standards for planning. This model can also be extended to conceptualize shared regulation in planning (Table 1). That is, groups' shared understanding of their task, goals and plans are generated through groups' cognitive operations and in turn affect the internal (group) and external (task and context) conditions.

Table 1
COPES of Self- and Shared Regulation in Planning

	Self-Regulation in Planning	**Shared Regulation in Planning**
Conditions	***Internal*** **Self**: e.g., My goals and plans, my knowledge and understanding of the course and task, previous knowledge about how to plan, as well as how to collaborate in groups, my preparations for the task and group planning phase ***External*** **Group**: e.g., My understanding of our groups' collective task perceptions, goals, and plans, commitment to the task, previous knowledge, previous learning experience. **Task and Context**: e.g., Other group members' goals and plans, other group members' knowledge and understanding of the task and the course, other group members' commitment to the task, descriptions of the Task, external technology support.	***Internal*** **Group**: e.g., Our shared understanding of our task, goals, plans, commitment to the task, previous knowledge, previous learning experience ***External*** **Task and context**: e.g., Other group members' goals and plans, other group members' knowledge and understanding of the task and the course, other group members' commitment to the task, descriptions of the Task, external technology support.
Operations	My cognitive operations (e.g., posting and sharing my own understandings of the task with my group)	Group members' own cognitive operations perform in groups (e.g., each group members post and share their opinions about task perceptions and plans)
Products	My task perceptions, my plans, and goals for the task	Our shared task perceptions, plans and goals for the task
Evaluations	My judgment about my task perceptions, goals, and plans	Our judgement about our task perceptions, goals, and plans
Standards	My criteria of task perceptions, goals, and plans	Our criteria of task perceptions, goals, and plans

Individual and Group Experiences in Collaborative Learning

As mentioned in the COPES model, students' evaluations can later become both internal and external conditions of regulation which also affect group members' operations performed in the learning process. As such, it is assumed that students' perceptions of planning in

collaborative learning also changes the planning conditions (both internal and external) as well as their operations performed during planning.

Self-regulated learning theories stress the importance of learners becoming aware of the challenges encountered during learning and actively adopting strategies to ameliorate those challenges. Therefore, an essential aspect of students' evaluations of planning is their perception of perceived planning challenges during the process. Research to date has examined individual learners' perceptions of challenges encountered during collaboration. For example, Järvenoja and Järvelä (2009) investigated the types of socio-emotional challenges perceived by students in collaborative learning and whether students have taken actions to address the challenges. The findings revealed that students experience all types of socio-emotional challenges (e.g., personal priorities, work and communications, teamwork, collaboration, and external constrains) during group work in which *Teamwork* was the most frequently recognized challenges (34.3%), followed by *Collaboration* (24.3%), *Work and Communication* (22.7%), and Personal Priorities (16%). Furthermore, Hadwin et al. (2018) examined the self-reported major challenges encountered during collaborative learning as well as extent to which those challenges affected the collaborative learning process. Among the four type of challenges (*Planning, Doing the Task, Checking Progress, Group Work*), students rated *Doing the Task* challenges as the most problematic challenges to affect their collaborative learning process, followed by *Planning* challenges as the second most severe type of challenge.

However, most studies that have examined perceived challenges in collaborative learning have collected and analyzed the self-reported challenges at an individual level. That is, how groups perceive challenges as a whole unit was not often considered. Therefore, there is growing concern in CSCL studies that studies of collaboration frequently over-rely on data collected at

the individual level (Barron, 2003). Shifting to group-level analyses may provide new insights in patterns of perceived challenges within a collaborative learning environment.

Technological Tools that Support Planning in Collaborative Learning

Given the significant role of planning, there is emerging interest in supporting SRL by leveraging the potential of technological tools. Two types of tools have shown promise in optimizing regulation processes in collaboration: scripts and group awareness tool. Scripts in CSCL usually provide direct support to individual learners and groups, whereas group awareness tool often facilitate the collaboration process using a non-direct way. To support planning processes, two types of planning-focused support tools have been proposed and researched to date.

Planning scripts provide straightforward prompts to individual learners and groups to guide planning in collaboration. These planning scripts purposefully foster environments where expected processes of activities and interactions can happen (recognized as "*macro-scripts*") to enhance collaborative learning (Dillenbourg & Hong, 2008), or give elaborated prompts (recognized as "*micro-scripts*") of what topics or issues should be discussed and negotiated in collaborative learning (Weinberger, Fischer, & Mandl, 2002), such us generating all-agreed task perceptions and setting goals.

Effect of Planning Scripts. Recent studies of CSCL examined the effect of planning scripts on different levels of support (high vs. low) and applied contexts (individual planning phase vs. group planning phase, e.g., Miller & Hadwin, 2015b; Hadwin, Webster, Bakhtiar, & Caird, 2015). In the high-support condition, students gave answers to planning questions by selecting from pre-stocked planning items. These items either matched or did not match the assigned task description, criteria, and purpose. In contrast, in the low-support condition, the

same questions were provided with an open-ended text field to document planning ideas. That is, only minimal guidance about planning topics were provided to students.

Miller and Hadwin (2015b) investigated the effect of CSCL supports on groups' construction of shared task perceptions for a collaborative task. Groups were assigned to one of four conditions (individual high/low support, group high/low support). Findings revealed that, regardless of individual support, high-level group support helped groups to co-construct more accurate shared task perceptions and engage in more transactive planning discussions.

Using the same tools, Hadwin et al. (2015) examined the effects of planning scripts on challenges encountered during collaboration. Overall findings suggest that scripting planning did not lead to better collaborative task performance. However, when high-level support during individual planning was provided, students reported fewer task management and engagement challenges during collaboration, compared to students who received low-level support. Findings also suggest that support for planning is not the more the better: students who received high-level scripting support in both individual and group planning reported a higher mean frequency of planning and task engagement challenges, than students who received high-level scripting for only individual or group planning alone. This suggests that too much support in the form of scripting may have a counteractive effect on collaboration.

These findings suggest that, to facilitate the construction of shared task perception and alleviate perceived challenges during collaboration, high-level planning scripts during individual planning phase, and low-level planning scripts during group planning phase should be provided for the best. More importantly, although difference in group performance were not detected, differences in the amount of perceived planning challenges were shown. These differences suggest two things. First, support tools like planning scripts engaged groups in planning, a

regulatory process that has previously been shown to be often neglected in collaboration. Second, these tools changed the way groups work and collaborate. However, what exactly these changes are remains unclear.

Visualizations, as a type of group awareness tool, illustrate graphical results to group members after each individual in the group interpreted the task by themselves. Awareness of similarities and differences that are generated by comparing individuals' own task understanding and that of others' in the group will then stimulate discussions among group members. This kind of tool is often recognized as group awareness tool in the form of visualization (Miller & Hadwin, 2015a; Miller, Malmberg, Hadwin, & Järvelä, 2013).

Effect of Visualization Tool. Past studies have examined two types of visualization tool used during planning: (a) graphical summaries of group members' responses with frequencies included (i.e., quantified visualizations), and (b) graphical summaries of group members' responses without frequencies (i.e., nominal visualizations; Miller, & Hadwin, 2015a).

Starcheski and colleagues (2017) examined the effect of visualization on regulation processes and targets. Their findings indicate that when providing nominal visualizations during planning, groups demonstrated more active planning discussions, compared to no visualization provided. However, no difference was found between quantified and nominal visualizations (Starcheski, Davis, Bakhtiar, Webster, Miller, & Hadwin, 2017).

Likewise, Hadwin et al. (2018) examined the effect of the visualizations on individual group member's perceptions of challenges and strategy success. Findings revealed that individuals, who belonged to groups that did not receive visualization support, reported planning as more problematic and reported *time and planning* as their main challenge. Meanwhile,

students who received no visualization support reported fewer successful strategies. Similarly, no difference was detected in the comparison of visualization types.

Webster and Hadwin (2019) examined students' self-reports of emotions and emotion regulation strategies during two back-to-back collaboration tasks under three types of group planning support (quantified visualization, nominal visualization, and no visualization). Overall findings suggest that students who received no visualization support demonstrated a positive shift in their emotions and strategy evaluations from one collaborative task to the next. Although this result was not expected, the author suggests that it might be due to the lack of communication between group members when adequate supports are provided during the first task. And these extra communications may help groups with their emotion regulation in the latter task.

In sum, although there are mixed findings about which type of visualization is more advantageous, previous research, in general, find positive effects of group awareness tool in the form of visualization on collaborative learning. For example, Starcheski et al. (2017) found that visualizations helped groups engage in more active planning discussions and Hadwin et al. (2018) found that visualization helps ameliorate planning challenges. However, despite evidence that visualization changes these planning and other regulatory outcomes, we know little about how this awareness tool changes the actual planning processes and interactions during collaboration.

Analysis of Planning Discussions

Planning support tools and technologies for collaborative learning have the potential to affect individual learners' and groups' collaboration. Therefore, investigating and comparing the essential characteristics and the overall quality of planning discussions that emerge during

collaboration may help us to detect the changes related to application of planning support tools. It is noted that the quality of planning discussions mentioned here refers to that of learning-groups which place emphasis on knowledge constructing, compared to that of working-groups, which focus more on task completing and products delivering.

Why focus on group discussions? There are gaps in the literature with regards to identifying and detecting specific mechanisms that underlie changes related to the intervention of a group awareness tool. Although research indicates changes to planning experience and the accuracy of task understandings, we do not know much about what the changes were and what happened in the process. Research indicates that although individual and group regulation of learning is a metacognitive process, the observable signs are group members' behaviours and interactions which reflect planning, enacting, monitoring, and evaluating processes at the individual level learning and the joint efforts of the group (Dillenbourg et al., 2009; Isohätälä, Näykki, & Järvelä, 2019; Järvelä & Hadwin, 2013). For collaborative learning in particular, regulatory processes start and are maintained through verbal discussions between group members (Dillenbourg et al., 2009; Nussbaum, 2008;). Thus, investigating planning discussions that emerge during group work will help us understand what has changed in collaborative learning, particularly during the planning stage.

Not all kinds of discussions among group members are equally valuable to collaborative learning and there is limited empirical research that has examined planning discussions in the context of collaborative learning (e.g., Rogat & Linnenbrink-Garcia, 2011; Starcheski et al., 2017). Studies focused on other knowledge-construction activities during group discussions may yield important processes that contribute to planning, as these regulatory processes are collectively part of metacognitive knowledge construction within collaborative learning.

Essential features of planning discussions and measurement. Previous studies have proposed essential features of discussions in collaborative learning and measured these features in authentic collaborative tasks.

Occurrence features. Occurrence features refers to the temporal and quantitative characteristics of group discussions when they emerge in collaborative learning, such us when it happens and how long/how much it happens. In self-regulated learning and later the social forms of regulation models, planning is identified as the first step as it sets the foundation for regulation and directs individuals and groups all the way to their goals (Winne & Hadwin, 1998; Hadwin et al., 2011, 2018). However, groups do not often spend quality time and effort on planning at the beginning. Instead, they tend to start right on the task or learning material itself because they believe that they would "run out of time" otherwise (Hadwin, 2017; Hadwin et al., 2018). Without adequate time and effort investigated at the beginning, groups would end up going back and forth on issues that associated with planning deficit (e.g., not being able to reach consensus during task enactment because of different understandings of the task).

Starcheski and colleagues (2017) examined discussion data to understand the occurrence of regulatory processes in collaborative learning. A multi-level coding approach was used to identify groups' regulatory processes. In this study, occurrence was measured by tallying words typed during the online collaboration tasks, with the exception of stop words (conjunctions and prepositions). The number of words contributed to each phase of the two collaboration tasks was then used to infer the engagement of regulatory processes, including planning.

Regulation Targets. Both individual regulation and group regulation theories (Hadwin et al., 2011, 2018; Winne & Hadwin 1998, 2008) emphasize taking active control of cognition, behaviour, motivation and emotions in learning processes. Research in the field has also paid

attention to what individuals and group members tend to control or pay more attention to during collaboration (e.g., Volet, Summers, & Thurman, 2009). Examining regulation targets may provide further insights into what group members attempt to control and regulate when they engage in regulatory processes.

Starcheski and colleague (2017) also examined the regulation targets of regulatory processes (including planning, enacting, and adapting). Chat data was coded by different regulation targets, specifically behavioral targets that were task-focused or strategy-focused. Distinguishing between task and strategy-focused behaviours allows us to better discern whether students attempt to focus more on getting the task done or whether the task was involved in constructing knowledge. Overall, they distinguished four types of targets emerged in conversational regulation processes: cognition, behavior-Strategy, Behaviour-Task Completion, and Motivation and Emotion. In the present study, these four categories were later been modified and renamed as planning knowledge construction, procedural planning, copying/repeating statements or resources, and socio-emotional contribution.

Transactivity. As mentioned in an earlier section, transactivity is one of the key features of SSRL which indicates the extent to which group members construct their joint metacognitive, cognitive, behavioral, emotional, and motivational states by adopting different perspectives. When students work together in groups, shared understanding of topics is constructed through negotiation (i.e., asking questions, discussing, explaining and providing supplemental information to support their viewpoints; De Lisi & Golbeck, 1999). These kinds of conversations are identified as transactive discussion (Teasley, 1997). Furthermore, recent research about technological support suggests that effective planning support can facilitate learners to construct more accurate shared task perceptions by transactively building on each other's ideas to

negotiate shared task perceptions (Miller & Hadwin, 2015b). Therefore, the transactivity of planning discussions warrants further investigation.

Miller and Hadwin (2015b) examined the degree to which groups transactively negotiated shared task perceptions during group planning. The degree of transactivity was scored on a scale from 1 to 5 with 1 indicating low transactive discussion (i.e., task perceptions came from a single group member and were simply accepted by the group without further discussion) and 5 indicating highly transactive discussion (i.e., task perceptions were suggested by multiple group members and then discussed, compared, and evaluated against the task criteria).

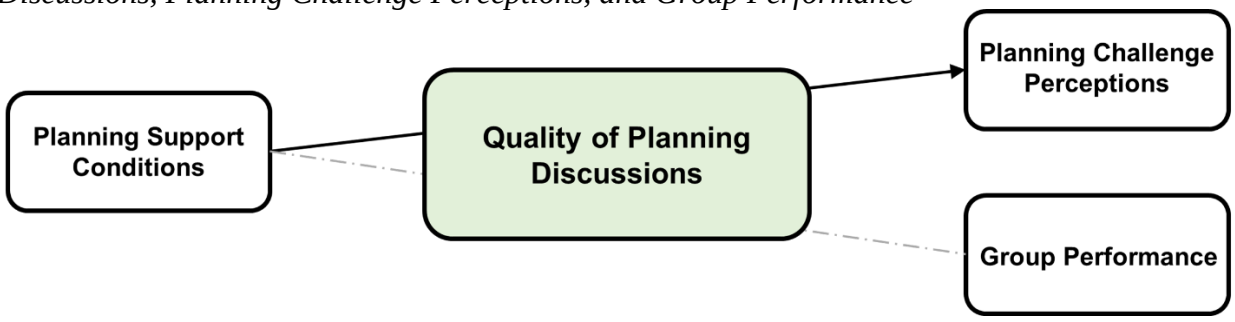
Popve and colleagues investigated whether synchronicity and transactivity can be used to predict the quality of collaboration products. By using the operationalization of integration from Noroozi's hierarchy of transactivity (Noroozi, Biemans, Weinberger, Mulder, & Chizari, 2013), chat discussions of all groups were coded for the occurrence of high-level transactivity (Popov, van Leeuwen, & Buis, 2017).

Accordingly, the occurrence features, regulation targets, and transactivity are important characteristics of planning discussions that need to be considered in the context of collaborative learning. Furthermore, although previous studies suggest that single indicators may not be able to represent the overall quality of discussions emerged groups (e.g., Popov, van Leeuwen, & Buis, 2017), future studies may be able to summarize the quality by describing the discussions from multiple aspects. By conducting a more comprehensive examination of groups' planning discussions, we better understand how planning support tools can change the regulation process of planning as well as group perceptions of planning challenges encountered during collaborative learning (see Figure 1).

To summarize, past CSCL studies have found planning support tools in the form of visualizations affect individual perceptions of planning challenge severity, yet no impact was found on group performance. Consider the relationship between conditions (planning support conditions), operations (quality of planning discussions), and evaluations (planning challenge perceptions) suggested by the COPES model may give us an opportunity to explain how planning support tools stimulate regulation during collaborative learning. On the other hand, although planning support was not found to directly influence group performance, its indirect effect can be examined by exploring the relationship between group performance and planning discussions, as well as planning perceptions (See Figure 1).

Figure 1

Assumptions of the Relationships between Planning Support Conditions, Quality of Planning Discussions, Planning Challenge Perceptions, and Group Performance



Research Purpose

The purpose of this qualitative case comparison study was to explore how the quality of planning discussions contribute to group performance and planning challenge perceptions, under the three different planning support conditions.

Research Questions

This study aims to answer the following research questions (See Figure 2):

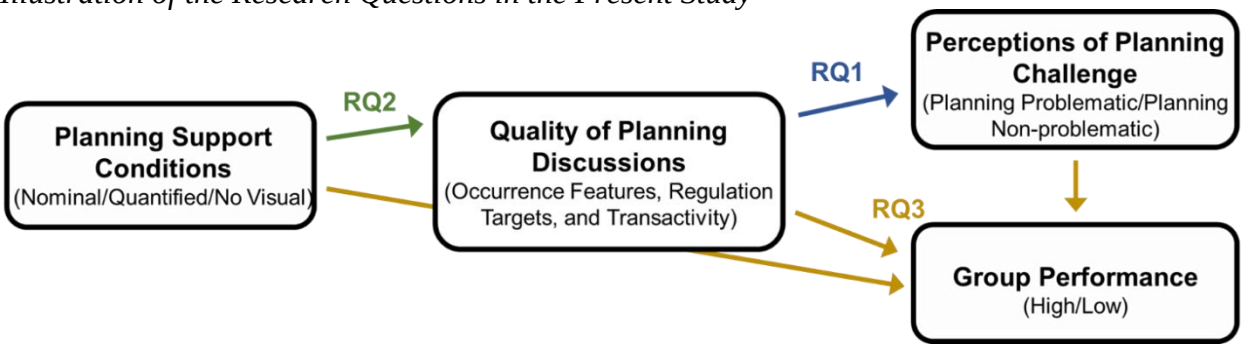
1. How does the quality of planning discussions differ among groups who reported problematic planning and groups who reported non-problematic planning?

2. How does the quality of planning discussions differ among groups who received different conditions of group awareness support?

3. Are planning support conditions, quality of planning discussions, and perceptions of planning challenge associated with group performance on the collaborative task?

Figure 2

Illustration of the Research Questions in the Present Study



Chapter 3: Methods

Contextualizing the study

This study took place in a first-year undergraduate learning strategies elective course that focused on (a) developing SRL knowledge, skills, and strategies; (b) developing metacognitive awareness of learning and collaboration; and (c) applying SRL to authentic learning tasks and situations. Researching regulation in a course that promotes it is valuable because otherwise research about SRL can be hindered due to the restriction of range when students are rarely familiar with strategies or tactics for learning and fail to productively self-regulate learning (Winne, 2014), or collaboration in the case of this study.

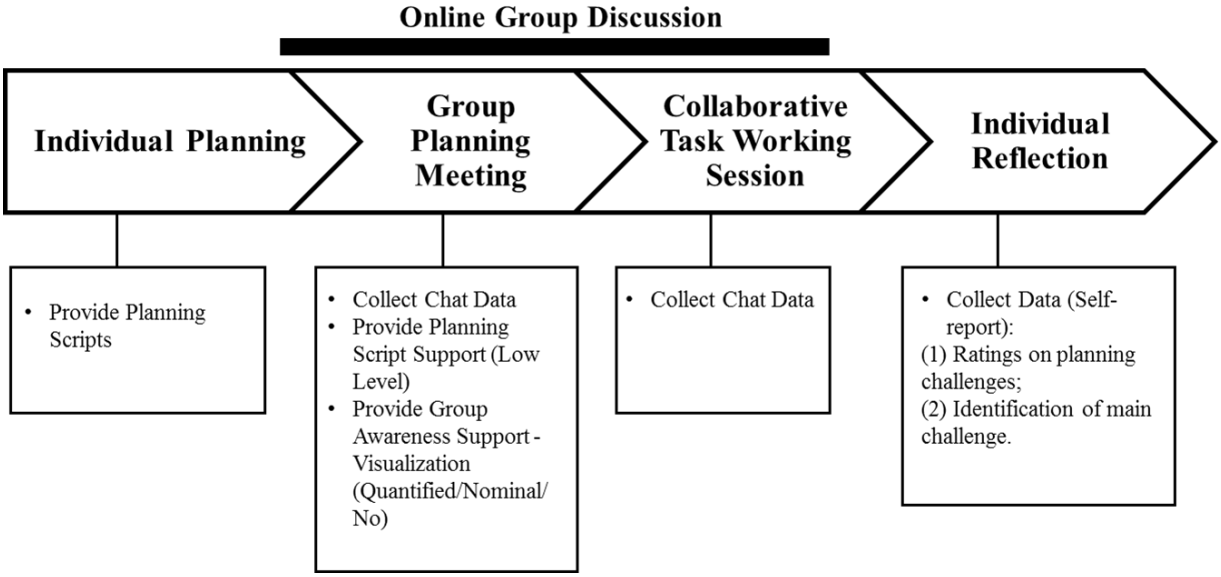
Data was collected in the context of a research-based course. Participants in the course were also consenting participants in the research unless they chose to decline consent. The terms of the research and how to decline consent were included in the course syllabus, shared with students two weeks prior to the start of the course and reiterated within the course itself (See Appendix A for the ethic approval and Appendix B for the consent form and process for declining consent).

The Collaborative Task

Students were required to complete a collaborative task assignment during week 7 of the course. Task products were graded for accuracy, use of course concepts, and alignment with the scenario-problem teams attempted to solve. The collaborative task contained three stages: (1) planning, including individual planning and group planning meeting; (2) collaborative task working session; and (3) individual reflection. Collaboration (Group planning meeting and collaborative task working session) occurred in a computer-supported collaborative learning

environment consisting of a (a) text-based chat tool and (b) collaboration wiki that was editable by one person at a time, and viewable by all group members.

Figure 3
Collaborative Task Design



The ***Planning*** *stage* required students to plan for the upcoming collaborative task working session in two stages. First, students completed an *individual planning* activity (10 minutes). Students were guided by high-level planning scripts prompting them to identify key task perceptions, and challenges they anticipated during the working session. Second, a week later, a ***group planning meeting*** (20 minutes) required groups to discuss, negotiate, and record written answers to a similar set of guided questions used for individual planning.

Groups were assigned to one of three planning support conditions designed to stimulate metacognitive awareness for planning (see Appendix C for examples): (1) Groups assigned to the *Quantified Visualization condition (Q-V)* were presented with a graphical summary of each group member's individual planning responses including information about the number of people who identified each planning idea or perception. (2) Groups assigned to a *Nominal Visualization condition (N-V)* were presented with a graphical summary of planning ideas or

perceptions selected by at least one group member with no information about the number of people selecting each option (3) Groups assigned to the *No Visualization condition (No-V)* were not provided with a summary of individual planning responses.

The ***Collaborative task working session*** required students to analyze a fictitious scenario (868 words) describing the experience of a student working on a major essay for an undergraduate history course. Together groups collaborated online using text-based chat and a wiki document to discuss, negotiate and record answers to a set of analysis questions. This was a 90-minute timed collaboration much like an applied exam.

The ***Individual reflection*** was completed by individual group members within a week of the collaborative task working session. It prompted students to reflect on the collaborative task work (see Appendix D) Specific to this study, participants were asked to (a) rate how much of a problem were a set of challenges (planning, doing the task, checking progress, and group work) on a Likert scale from 1 (*not a problem*) to 5 (*major problem*); (b) identify their main challenge by choosing from a dropdown list of 22 challenges (See Appendix E). These 22 challenges are elaborated situations each falls into one of the four challenge categories: *Planning*, *Doing the Task*, *Checking Progress*, or *Group Work*. This study focused on ratings of planning challenges and identification of planning difficulties exclusively.

Individuals' answers on whether planning had been problematic, and identifications of major challenge were collected and analyzed to select groups in which members perceived similar level of planning challenges (Planning Problematic/Planning non-Problematic).

Research Design

Participants

Participants were drawn from a convenience sample of 180 undergraduate students (106 females) enrolled in a first-year elective course in a university in western Canada (Mean age = 19.22, SD = 2.08), among which 62.38% were first-year students. All participants were assigned to groups of three members (10 groups), four members (28 groups), or five members (8 groups) by the course instructor. Groupings attempted to maximize heterogeneity based on language proficiency, previous quiz performance, academic major, and gender.

Extreme Case Sampling Method

Extreme case sampling was used to select groups that indicated (a) planning was problematic, and (b) planning was not problematic (see Table 2).

Planning Problematic Groups were identified according to two criteria. First, 50% or more of group members identified a planning challenge as their main challenge in collaboration. Second, the mean rating of planning as a problem was relatively high across group members. For this second criteria both group-mean rating and standard deviation were taken into consideration. Of note, three of the six groups meeting these two criteria, had at least one group member who failed to submit the individual reflection or report on challenges encountered during collaboration. For example, Group H1 contained four members but only two of four group members submitted an individual reflection. Those two group members identified planning as the main challenge, and also rated planning challenges as highly problematic (mean = 4.50, SD = 0.71). Group H1 was included because failure of the other two group members to submit the individual reflection, may be an indicator of problem. 6 groups were selected for this study.

Planning Non-Problematic Groups were identified according to three criteria: (a) all group members submitted an individual reflection, (b) no group member identified planning as the main challenge in collaboration; and (c) the mean rating of planning as a problem was relatively low. Of the 22 groups meeting criteria (a) and (b), 6 groups with the lowest mean rating of planning as a problem were selected for this study.

Table 2 provides criteria data for groups selected for the problematic (H1, H2, H3, H4, H5, H6) and non-problematic (L1, L2, L3, L4, L5, L6) case comparison. Importantly, researchers were blinded to the visualization support conditions during the data coding and analysis phase.

Table 2
Comparison of Extreme Case Sampling Groups by Selection Criteria

Group*	Group Size	Number of People Completed Solo Reflection/Group Size	**Number of Students Identified Planning as Major challenge**	Group mean Rating on Planning as a Problem	SD	Individual Rating on Planning as a Problem			**Visualization Support Condition***
						Low	Moderate	High	
H1	4	2/4	**2/2**	4.50	0.71	/	/	4, 5	No Visual
H2	4	4/5	**2/4**	2.50	1.29	1, 2	3	4	Nominal
H3	4	4/4	**2/4**	2.75	1.71	1, 2	3	5	Nominal
H4	4	4/4	**3/4**	1.75	0.96	1, 1, 2	3		No Visual
H5	4	4/4	**2/4**	3.25	1.50	2, 2		4, 5	No Visual
H6	4	3/4	**3/3**	2.33	1.15	1	3, 3		Quantified
L1	4	4/4	**0**	1.25	0.50	1, 1, 1, 2	/	/	No Visual
L2	4	4/4	**0**	1.25	0.58	1, 1, 1, 2	/	/	No Visual
L3	3	3/3	**0**	1.67	0.58	1, 2, 2	/	/	Quantified
L4	3	3/3	**0**	1.67	0.58	1, 2, 2	/	/	Quantified
L5	4	4/4	**0**	1.75	0.50	1, 2, 2, 2	/	/	Nominal
L6	4	4/4	**0**	1.50	0.58	1, 1, 2, 2	/	/	Quantified

* Groups being named with H at the beginning refers to the planning problematic groups, whereas groups being named with L at the beginning refers to the planning non-problematic groups.

Collaborative Planning Discussion Processing and Coding

The primary data source for this exploratory case study was chat transcripts collected during the group planning meeting and collaborative task working session (see Figure 3). All chat transcripts were extracted from the online wiki chatting software and imported to NVivo 11 for coding.

Chat transcripts were processed in two steps. First, planning statements and planning discussion episodes were identified. Second, planning statements and planning discussions episodes were coded for three quality indicators: (a) Occurrence including planning quantity, timing of major planning, and average length of planning discussions, (b) regulation targets, and (c) transactivity for further comparison.

Step 1. Identifying Planning Statements and Planning Discussion Episodes

Planning Statements. Every time a group member posted something in the chat box, it was considered a statement. One statement contained one or more sentences, words, or emoticons. If one person spoke more than once in a row, but posted statements separately, they were considered as different statements. Furthermore, if a statement is been coded as planning in terms of regulatory process, then it is identified as a planning statement (See Table 3 for the coding scheme). It is noted that, if the regulatory process of a statement has been coded as orienting, but it followed with planning statements, then the former statement would also be identified as a *planning statements* since it sets a stage for a coming discussion focused on planning.

In this study, coding of statements in terms of regulatory process were reviewed and modified from a previous coding done in Bakhtiar et al.'s study (2018).

Table 3
Coding Scheme of Regulation Process

Regulatory Process	Description	Example
Orienting	- Situating or positioning self or others in terms of the group, surroundings, and task. Low level coordinating statements/ announcements where the main purpose is to situate themselves (or self)/move things along.	*- [While members are logging on to the chat:] hey guys, are we all in the chat now?* *- [While members are logging on to the chat:] hey guys I'm ready whenever you are* *- [at end of task] I'm logging out / I have to go now / me too*
Planning	- About defining task perceptions, setting goals, and making plans for the task. - About what the group or individuals should/could do and what is required (often future tense). - This can include: Determining roles and responsibilities; Plans to carry out a strategy or adapt; Considering different options for what to do; Answering the Planning Questions.	*- [Answering the question about what the task is asking them to do:] I think we need to analyze a problem case scenario and identify all SRL strengths and weaknesses* *- Yes! Okay.*

Planning Discussion Episodes. When a series of *planning statements* interrelated by one focus, these *planning statements* together were identified as one *planning discussion episode*. *Planning discussion episodes* only contains *planning statements*. For example, the seven *planning statements* together make up a *planning discussion episode*.

> *A: Ok. We have to figure out the most important thing in the coming task.*
> *B: For this question, I put Working Well together, Knowing what to do, and Demonstrating what I know. What'd you guys have?*
> *C: Combining all of them? Do we have to choose one of them?*
> *A: A 21 century skill that we should all have?*
> *D: For the Collaborative Challenge the things that are most important to us are: Working well together, knowing what we need to do by having a solid plan, and in turn, demonstrating what we know. Make any edits you guys want to.*
> *A: That covers everything.*
> *B: Great.*

Step 2. Coding/Scoring for Planning Indicators

Three planning indicators were coded and scored at this step: (a) *occurrence features* (*planning quantity*, *timing of major planning*, and *average length of planning discussions*), (b) *regulation targets*, and (c) *transactivity*.

(a) Occurrence features

Quantity of planning refers to the words investigated in planning discussions during collaboration. After all the planning statements had been identified from chat transcripts, the number of typed words in each planning statement were counted[1]. The word counts number of each planning statement, the word counts number in each planning discussion episode, in the group planning meeting, the later collaborative task working session, and across the entire collaboration process were also documented separately.

Average length of planning discussions. The *average length of planning discussions* indicates the length of single *planning discussion episode* emerged in groups. To measure this indicator, frequency of planning discussion episodes across the two stages of the collaborative task were counted. The average length of planning discussions was calculated by having the overall quantity of planning divided by the frequency of planning discussion episodes across the two stages (the group planning meeting and the collaborative working session) of the collaborative task. For example, if 20 planning discussion episodes emerged in collaborative task across the two stages, and 1000 words were typed in all the planning statements, then the average length of planning discussions would be documented as 50 words per episode.

Timing of major planning. *Timing of major planning* indicates whether the majority of planning discussion episodes emerged during the group planning meeting, or the collaborative working session, based on the number of words spent in planning discussion episodes. This indicator was not initially identified as a quality measure since we assumed that the majority of planning discussions would naturally happen during the group planning meeting when groups

[1] Note: A few special cases in terms of counting words:
(1) An abbreviation was only counted for one word. For example, "SRL" was counted for one word, whereas "self-regulated learning" was counted for two words.
(2) Emoticons in planning statements were not counted.

were assigned the task of planning and essential planning questions were provided to assist with the planning process. However, we find out that it does not always turn out that way and it kept coming up during the analysis, so this indicator was added during coding.

(b) Regulation Targets

Regulation target refers to the regulatory purpose of a conversation. If a group was only trying to get the assignment done without attention to the process of constructing planning knowledge, their planning discussions would largely focus on the behavioral actions, like detailing tactics or plans of how to get through the process. These statements were coded as procedural planning in terms of *regulation targets*.

Planning statements were coded as either one of the four categories: *Planning Knowledge Construction*, *Procedural Planning*, *Copying/Repeating Statements or Resources*, and *Socio-Emotional Contribution*. The proportions of regulation targets of planning statements were counted for group planning meeting, the collaborative task working session, and the entire collaboration process (See Table 4 for the coding scheme).

Table 4
Coding scheme of regulation targets (Starcheski et al., 2017)

Regulation Targets	Description	Examples
Planning Knowledge Construction	Statements where the group or an individual engaged in planning, monitoring, or adapting with the intent to take control of thinking in the task. Thinking processes include memory, learning, problem solving, understanding, comprehension, and awareness.	*- I think we need to learn to how to collaborate and analyze the scenario using course concepts.*
Procedural Planning	Statements where the group or an individual engaged in planning, enacting strategies, monitoring, or adapting with the intent to take control of behavioral engagement of the team or a member. Relating to how strategies are being enacted.	*- We need to finish this now, then we will move on to the solo check-in.* *- Hurry up, guys!*
Copying/Repeating Statements or Resources	Answering questions; knowledge contribution.	*- The answer for A is task understanding.*
Socio-Emotional Contribution	Attempts to control socio-emotional conflicts, motivational beliefs, engagement, or experienced emotions.	*- I was quite stressed out being the editor last time. I prefer not to do it again.*

(c) Transactivity

Transactivity refers to the extent to which group members build on each other's ideas. When a group does not develop shared knowledge construction during collaboration, they tend to have surface-level conversations comprised of simply agreeing with other people's statements without further discussion.

Planning discussions episodes were coded into five transactivity levels from 1 (Low) to 5 (High). See Table 4 for the coding scheme, which was revised form the transactivity coding scheme earlier designed by Miller and Hadwin (2015b).

Table 5
Coding scheme for Transactivity Levels

Description	Examples
Low (1) Plans, goals, or task perceptions come from a single group member and are simply accepted by the group without further discussion.	*Varun: Catherine do you want to edit?* *Catherine: ok I will edit.* *Lee: I'm good with that.* *Taylor: I agree.*
Moderately Low (2) Plans, goals, or task perceptions come from multiple group members and are simply accepted by the group without further discussion.	*Varun: ok for question 2, I think we are doing this to improve our goals and understanding different concepts.* *Lee: I agree, we are applying concepts to working as a group.* *Catherine: To get how to be efficient.* *Lee: okay.*
Moderate (3) Plans, goals, or task perceptions suggested by multiple group members and are discussed/compared. Unclear why one idea was accepted over another.	*Riley: Question 2. Why are we doing the collaborative challenge?* *Yuan: To build on each other's knowledge.* *Yuan: To learn to solve an academic problem within a time limit* *Riley: To learn to collaborate.* *Mischa: So is it to build each other's knowledge, to learn to collaborate, to apply course concepts to solve a problem?* *Yuan: I like Mischa's answer.*
Somewhat High (4) Plans, goals, or task perceptions suggested by multiple group members and are discussed/compared. Group uses shallow criteria for selection unrelated to the task (e.g., most popular answer)	*Larisa: Okay, question 6. What's the biggest challenge we anticipate facing?* *Connor: I think it will be communicating online and not in person* *Connor: and time* *Larisa: biggest challenge* *Emily: everyone can show their ability* *Larisa: what else is going to be a challenge?* *Emily: Different culture and language* *Connor: We need to give very in-depth answers because they expect good ones with a group of 4.* *Connor: Ya culture and language*
High (5) Plans, goals, or task perceptions suggested by multiple group members and are discussed/compared. Group uses task related criteria for selection.	*Tara: I agree with all of your suggestions Amy except I don't think we need to "summarize the students problems" because if when we're analyzing the scenario it it's means we have to do a lot more than just describe it* *Amy: ok so would "analyze SRL strengths and weaknesses" be better?* *Zach: Yes, I think so.*

Group Performance on the Collaborative Task

The institutional grade of the collaborative task completed in the course were collected to indicate groups' performance on the collaborative task. A median split strategy was used to

distinguish groups who performed high in the collaborative task and groups who performed low in the collaborative task.

Rigor of the Qualitative Research

Following protocols were applied to ensure the rigor of this qualitative research (Lincoln & Guba, 1986).

(a) To ensure the findings of this qualitative inquiry are repeatable, the process and details of the collaborative task, data collecting, data coding, are well-recorded and repeatable. The field notes recorded by the course instructor team were all archived and considered during data coding and analysis.

Regulation processes and regulation targets were previously coded by two other coders. The inter-rater reliability index for coding of regulation targets was Cohen's K =.93, the index for coding of regulation processes was Cohen's K = .87. In the present study, all chat discussions data was recoded for regulation processes and regulation targets. The coding results were all compared with previous results.

(b) To ensure that the results are true and credible, all the coders, as well as the course instructional team are all well-versed in educational psychology knowledge as well as self-regulated learning theories.

The coder of the present study spent more than three months becoming very familiar with all the chat discussion data and the context of all the coded episodes. Additionally, the coding processes were regularly reviewed and debriefed with a key member of the project.

(c) To extend the degree to which the results can be transferred to other settings, a purposeful sampling strategy was used to distinguish groups who collectively identified planning problematic and groups who did not. Thick description about groups and task conditions was

provided. Wherever possible discussion quotes were provided to illustrate coding processes and contextualize reported findings.

Chapter 4: Results

This chapter is presented in three parts. In part one, narratives regarding what happened in the groups are presented to capture the overall context of groups' planning processes. In part two, the groups' planning statements and planning discussion episodes were coded and scored on each planning indicator; additionally, at the end of this part, the overall qualities of groups' planning discussions are rated. Lastly, in part three, the research questions proposed in the present study were addressed by comparing the quality of planning discussions between groups who perceived planning problematic and groups who perceived planning non-problematic, among groups who received nominal/quantified/no visualizations during collaboration; and between groups who performed high/low in the collaborative task.

Part 1. Narratives of Groups' Planning Processes

This section begins with brief narratives describing groups' overall planning processes and distinguishing features. Additionally, the narratives also include concrete major challenges identified by individual group members.

Group H1. Overall, the planning process of group H1 had twists and turns. One group member in group H1 almost missed the group planning meeting (this student posted a question about their responsibility, but no one replied) and did not participate in the later collaborative task working session. Additionally, this student did not submit the reflection. That is, although the registered group size is four, this group actually contained three group members. Of the three remaining group members, two submitted their reflections. In terms of the content of their planning discussions, this group was constantly changing the role of editor and therefore most of

their planning discussions were just short talks deciding who should be editor at the time. After someone posted an idea, the group usually just accepted it without further discussion.

Regarding the individual-reported major challenges, the two group members who submitted their reflection identified planning challenges as their major challenge during the collaboration process. More specifically, one chose ‘Different ideas about how to organize our time’ and the other chose ‘Different goals/standards for our work’.

***Group H2*.** Overall, the planning process of Group H2 was relatively smooth. All group members engaged in the entire process, and they worked on most of the planning questions (provided in the group planning meeting) together. According to the course instructors’ record, it is assumed that some planning processes happened outside the course, which was not captured in the online transcripts, but it was minimal.

Regarding the individual-reported major challenges, half group members (two out of four) identified planning challenge as their major challenge during the collaboration process. The reported planning challenges are ‘Different understandings of what we need to do (one group member)’ and ‘Different ideas about how to start (one group member)’. Other selected major challenges are ‘Different ideas about when to check progress’, which falls under the category of *Checking Progress*’, and ‘Unequal participation or distribution of work’, which falls under the category of *Group Work.*

Group H3. In general, the planning discussions in Group H3 were dedicated and in-depth. All group members participated in the entire collaboration process and worked on the planning questions together during the group planning meeting. In terms of planning discussions, group

H3 tended to engage in long and rich conversation on one single topic before heading to the next, and these long conversations were mostly about the planning questions provided during the group planning meeting.

Regarding the individual-reported major challenges, two out of four students reported planning challenges as their major challenge: ‘Different goals/standards for our work’ and ‘Different ideas about how to organize our time’. The other two group members reported ‘Trouble with running out of time (*Doing the Task*)’ as their major challenge.

Group H4. The planning discussions in group H4 appear decent; however, if we take a deep look into the group’s planning discussions, we might find some problems. For example, the two longest planning discussions were not about discussing or negotiating the provided planning questions: one was about arranging another appointment for the group members to meet since there was a student who had to leave at the moment; the other discussion was mainly about an individual in the group sharing the content of their summary sheet. In terms of interactions between group members, when this group discussed procedural plans like who is going to edit the answers, or specific tactics of how to enter the answers, their conversations tended to be more transactive (contains more back-and-forth negotiations among group members). However, when the topic was about the actual answers to the planning questions, the conversations often lacked discussions, negotiations, and comparisons.

Regarding the individual-reported major challenges, three out of four group members reported planning challenges as their major challenge. Specifically, the selected planning challenges are ‘Different ideas about how to work together (two group members)’ and ‘Different

ideas about how to start'. The rest group member identified 'Trouble with running out of time (*Doing the Task*)' as the major challenge.

Group H5. Group H5 hardly engaged in any planning discussions since they assigned the planning questions to individuals to get it done without any negotiating or aligning processes. Except for assigning planning questions to individuals, group H5 did not engage in any conversations to discuss the planning-related issues prompted by the provided planning questions. "It appears that they either did not do the group planner, or one person went in to finish it", as recorded by the course instructors.

Regarding the individual-reported major challenges, two out of four group members identified planning challenges as their major challenge. Specifically, the selected planning challenges are 'Different ideas about how to start (*Doing the Task*)' and 'Different ideas about how to organize our time (*Doing the Task*)'.

Group H6. Similarly, group H6 did not engage in lots of planning discussions since they assigned the planning questions to individuals to get it done without getting agreement from other group members. Except for assigning planning questions to individuals during the group planning meeting and deciding the editing plan during the collaborative task working session, group H6 did not engage in any conversation to discuss the planning-related issues prompted by the provided planning questions.

Regarding the individual-reported major challenges, all three group members reported planning challenges as their major challenge. Specifically, the selected planning challenges are 'Different ideas about how to start' and 'Different ideas about how to organize our time (2 group

members)'. The other two group members selected 'Trouble with running out of time (*Doing the Task*)' and 'Trouble understanding each other (*Doing the Task*)' as their major challenge.

Group L1. The group planning process in Group L1 was relatively smooth. All group members participated in the entire collaboration process and worked on the planning questions during the group planning meeting. Usually multiple group members suggested ideas, and the group adopted all these suggestions without further discussion.

Regarding the individual-reported major challenges, no one in group L1 reported planning challenge as their major challenge. The selected major challenges are 'Trouble understanding each other' (*Doing the Task*; one member), 'Trouble with running out of time (*Doing the Task*; one member)', 'Different working styles (*Doing the Task*; one member)', and 'Different ideas about when to check progress (*Checking Progress*; one member)'.

Group L2. Similar to the situation described in Group L1, all members in group L2 engaged in the entire collaboration process and worked on the planning questions together during the group planning meeting. The group mostly just adopted everyone's ideas.

As for individual-reported major challenges, no one in this group reported planning challenges as their major challenge. The selected major challenges are 'Trouble understanding each other' (*Doing the Task*; one member)', 'Trouble with running out of time (*Doing the Task*; one member)', and 'Difficulty communicating due to language barriers (*Group Work*; 2 members)'.

Group L3. Group L3 hardly discussed any planning issues together as a team, and group members each worked on some planning questions and then reported their answers to the group. In most situations, these answers were just accepted and submitted without further discussions.

No one in Group L3 reported planning challenges as their major challenge; instead, all three group members selected 'Trouble with running out of time (*Doing the Task*)'.

Group L4. The planning process in group L4 was pretty smooth compared to other groups. Every group member participated in the entire collaboration and actively suggested ideas. It appears that group L4 tended to engage in long and in-depth discussions with many planning issues being discussed thoroughly.

No one in Group L4 reported planning challenges as their major challenge. The selected major challenges are 'Difficulty communicating due to language barriers' (*Group Work*; two group members), 'Different ideas about what to do when run into problems' (*Checking Progress*; one member).

Group L5. Group L5 also assigned the planning questions to individuals. After each group member completed their assigned questions, they reported the answers to the group and then slightly discussed these answers with other group members. Not all the answers were discussed.

No one in group L5 reported planning challenges as their major challenge. The selected major challenges are 'Different styles of interacting (*Group Work*; one member)', 'Different ideas about how to check progress (*Checking Progress*; one member)', 'Different strategies or approaches (*Doing the Task*; one member)', and 'Trouble using the technology (*Doing the Task*;

one member)'. A fact about this group: All group members chose different challenges as their major challenge.

Group L6. Group L6 also assigned the planning questions to individuals and then adopted individuals' answers. In general, all these answers were just accepted and submitted without any discussion.

As for individual-reported major challenges, no one reported planning challenge as their major challenge. Three group members selected 'Trouble with running out of time (*Doing the Task*) and one group member selected 'Different understandings of the course material (*Doing the Task*)' as major challenge encountered during collaboration.

In general, groups' planning processes described in the narratives revealed three important findings: First, regardless of group perceptions of planning challenge, many groups did not take full advantage of the planning questions provided in the group planning meeting. Rather than discussing and constructing answers, groups tended to assign the questions to individual group members and completed the questions separately.

Second, although coded as planning discussions based on their regulation process, many discussions emerged during the group planning meeting were not about the issues prompted by the group planner. For example, the situation described in Group H4: the two longest planning discussions were not about the planning questions (e.g., "what we are being asked to do", "why we should do it", "what the most important thing is"). Instead, the longest planning discussions was about arranging another appointment for the group members to meet since there was a student who had to leave at the moment, and the other discussion was mainly a group member

sharing the content of their summary sheet. These situations need to be considered when we evaluate the quality of planning discussions.

Third, time-related challenges were most frequently reported. For students who believe planning was their biggest challenge in collaboration, most of them selected 'Different ideas about how to organize our time', followed by 'Different ideas about how to start'. For students who did not chose planning type of challenges as their major challenge in the collaboration process, most of the selected major challenges fall under the challenge-category of '*Doing the Task*'. And more specifically, "Trouble with running out of time" is notably the most popular option. That is, regardless of group perceptions of planning challenge, time arrangement was also a big issue for groups (See Table 6).

Table 6
Challenges Identified by Students as Major Challenge and Frequency

Challenge Categories	Specific Challenge Items	Number of People Identifying as Major Challenge
Planning	Different ideas about how to organize our time	5
	Different ideas about how to start	4
	Different goals/standards for our work	2
	Different ideas about how to work together	2
	Different understandings of what we need to do	1
Doing the Task	Trouble with running out of time	12
	Trouble using technology	1
	Different working styles	1
	Different strategies or approaches	1
	Different understandings of the course material	1
Checking Progress	Different ideas about when to check progress	3
	Different ideas about what to do when run into problems	1
Group Work	Difficulty communicating due to language barriers	4
	Trouble understanding each other	3
	Unequal participation or distribution of work	1
	Different styles of interacting	1

Part 2. Evaluating Quality of Planning Discussions

The qualities of groups' planning discussions were evaluated based on the three planning indicators: *Occurrence features* (*including planning quantity, timing of major planning, and average length of planning discussions), regulation targets*, and *transactivity*.

Planning Quantity

Given online conversations being almost the only way for group members to interact during collaboration, sufficient amount of planning discussions must occur to share, compare, discuss, and modify task perceptions goals, and plans. Word count provides some indicator about the amount of discussion that occurred. High word counts may indicate that groups paid enough attention on planning and engaged in adequate amount of planning discussions to co-construct shared task understandings and build all-agreed goals and plans. Low word counts may indicate that groups neglected the step of planning and did not have enough chances to share task perceptions, to set goals, or to make plans.

Table 7 reports the total number of words during discussions coded as "planning" for each group. Groups with more than 800 words in planning discussions (Groups H4, H2, H3, L4, and L6) were categorized as high in quantity of planning. Groups with word counts of 400 to 800 words during planning discussions were categorized as 'Moderate' (Groups H1, L1, L2, L5 and L3). Groups with word counts less than 400 focused on planning were categorized as 'Low' (Group H6 and H5) in quantity of planning.

Particularly, the situation described in Group L4's narrative is considered since the two longest planning discussion episodes were not about the planning issues prompted by the planning questions. At the end, the identification of Group H4's planning quantity is not

modified since the word count is still above 800 words with the two controversial discussions being excluded (949 words remained).

Table 7
Groups' Planning Quantity

Group	Word Count	Planning Quantity
H4	1355	High
H2	1329	High
H3	1202	High
L4	1168	High
L6	1085	High
H1	799	Moderate
L1	624	Moderate
L2	558	Moderate
L5	477	Moderate
L3	474	Moderate
H6	335	Low
H5	129	Low

Timing of Major Planning

Due to the fact that groups engaged in planning discussions in both the stage of Group *Planning Meeting* and the later stage of *Collaborative Task Working Session*, a question kept showing up during the analysis. That is, when did the majority of planning happen? And in order to discuss the question independently and to disentangle this factor from the analysis of other planning indicators, the new indicator, *Timing of Major Planning*, is added to the catalogue.

In this study, online discussions happened across two collaborative sessions: (a) the group planning meeting lasted for a week and required students to work together to make plans for their collaboration; and (b) the collaborative task working session occurred over 90 minutes and required students to solve a collaborative problem together. Before measuring the quantity of planning discussions, we assumed that the majority of planning discussions would emerge during the group planning meeting. This assumption was made for two reasons: First, groups had more

time and were prompted to discuss planning related questions provided by the group planner tool. Second, groups were pressed for time to complete the task in the collaborative working session with very limited time to devote to other issues. However, during analysis it became clear that not all groups optimized planning meeting opportunities. For some groups, the majority of planning discussion emerged during the actual collaborative task working session.

From a self-regulated learning perspective, the four phases are theorized to be recursively and loosely linked meaning that planning is revisited and revised throughout learning sessions (Winne & Hadwin, 1998). Therefore, groups should be expected to return to planning as they progress through the collaborative task. However, given the timed nature of this collaborative task, time devoted to planning was coupled with time away from the collaborative problem solving. It was not efficient for groups to delay the majority of planning until the collaborative task working session.

Table 8 displays the word counts for planning during the group planning meeting versus the collaborative task working session. For example, group H1 and H6 had the majority of their planning discussions emerged during the collaborative working session. These two groups seemed to quickly complete the planning questions during the group planning meeting with very few words posted. However, the planning-related issues remained unsolved and showed up in the next stage. In this case, the amount of planning discussions increased compared to the group planning meeting stage. This pattern of more engaged planning discussion during the collaborative task working session compared to the group planning meeting is coded as '*reactive planning*'. In contrast when groups engaged in early planning with most of the planning discussions occurring before the collaborative working session, it is coded as '*proactive planning*' (see Table 8). Groups H2, H3, H4, L1, L2, L3, L4, L5, and L6 engage in '*proactive*

planning' having the majority of their planning discussions emerged during the group planning meeting. Importantly, timing of major planning of Group H5's planning was coded as '*negligible*' due to their extremely low amount of planning discussion across either session.

Table 8
Timing of Planning

Group	Planning Words in the Group Planning Meeting	Planning Words in the Collaborative Task Working Session	Timing of Major Planning	Planning Pattern
H1	324	475	Collaborative Task Working Session	**Reactive** Planning
H6	133	202	Collaborative Task Working Session	**Reactive** Planning
H2	1043	286	Group Planning Meeting	Proactive Planning
H3	1143	59	Group Planning Meeting	Proactive Planning
H4	1105	250	Group Planning Meeting	Proactive Planning
L1	458	166	Group Planning Meeting	Proactive Planning
L2	519	39	Group Planning Meeting	Proactive Planning
L3	357	117	Group Planning Meeting	Proactive Planning
L4	1132	36	Group Planning Meeting	Proactive Planning
L5	331	146	Group Planning Meeting	Proactive Planning
L6	880	205	Group Planning Meeting	Proactive Planning
H5	103	26	Negligible	Negligible

Average Length of Planning Discussion

Different from the first indicator – *planning quantity*, which indicates the overall number of words used in planning during collaboration, the *average length of planning discussion* indicates the average number of words used in each single planning discussion episode. Given the premise that planning discussion episodes were segmented by planning topics, this indicator helps identify the groups who had plenty of planning discussions but were constantly changing topic. That is, when groups' planning quantity were at similar level, the average length of planning discussions helps describe whether the group tended to have solid discussion about one planning related topic before heading to the next or preferred to quickly go through more topics.

From the perspective of average length of planning discussion, good planning contains lengthy and in-depth planning discussion with more words used to discuss each single planning

issue, whereas weak planning contains short and brief planning discussions with low number of words used to discuss each single planning issue.

The average words per planning discussion are reported in Table 9. Groups with average words per planning discussion higher than 50, were coded as having 'lengthy' planning discussions (Groups H3, L4, and H2). Groups with mean words per planning discussion between 30 and 50 words, were coded as 'moderate' (Groups L2, L6, L5, H4, L1, and H5); and lastly, groups with average words per planning discussion lower than 30 words, were coded as having 'brief' planning discussions (Group H1, L3, and H6).

Of note, group H4's average words per planning discussion was modified by excluding two planning discussion episodes. This was conducted because the two longest planning discussion episodes emerged due to two special circumstances (See group H4's narrative). This modification dropped the average words per planning discussion from 50.2 (lengthy) to 35.1 (moderate).

Table 9

Average Length of Planning Discussion

Group	Mean Words per Planning Discussion	Planning Discussion
H3	100.2	Lengthy
L4	61.5	Lengthy
H2	51.1	Lengthy
L2	46.5	Moderate
L6	43.4	Moderate
L5	39.8	Moderate
H4	35.1 (Modified from 50.2)	Moderate (Modified from Lengthy)
L1	34.7	Moderate
H5	32.3	Moderate
H1	29.6	Brief
L3	26.3	Brief
H6	23.9	Brief

Regulation Targets

Theoretically, when planning questions are provided to scaffold planning discussion, good planners leverage those prompts to construct planning knowledge, whereas weak planners attend to answering the questions and getting the planning activity done (procedural planning). Both constructing planning knowledge and controlling the process are important, however, when group members pay most of their attention to getting the planning questions done, rather leveraging the process to interpret the task and translate it into group goals and plans, the effectiveness of the group planning meeting would be largely reduced.

Table 10 reports the percentage and ratio of planning statements that focused on planning knowledge construction compared to procedural planning. Lower ratios indicate more emphasis on procedural planning. Higher rations indicate more balance between planning knowledge construction and procedural planning. The results showed that groups tended to focus on procedural planning (recording an answer to the questions they were given to prompt planning), instead of constructing shared perceptions and knowledge. Groups H3, L1, L2, L4, and L5 were identified as ‘high’ in constructivity with decent percentage of planning statements focused on constructing planning knowledge, compared to the percentage of planning statements focused on procedural planning (Ratio higher than 0.5). Group H1, H2, H4, and L3 were identified as ‘Moderate’ in constructivity with moderately low percentage of planning statements focused on constructing planning knowledge (Ratio higher than 0.3, and lower than 0.5). And lastly, group H5, H6, and L6 were identified as ‘Low’ in constructivity with hardly any planning statements focused on constructing planning knowledge (Ratio lower than 0.3).

Table 10
Percentage of Planning Statements Focused on Planning Knowledge Construction versus Procedural Planning

Group	**a**. Percentage of Planning Statements Focused on **Planning Knowledge Construction**	**b**. Percentage of Planning Statements Focused on **Procedural Planning**	Ratio of a/b	Constructivity
L-2	43%	57%	0.75	High
H-3	41%	57%	0.72	High
L-1	40%	56%	0.71	High
L-4	35%	59%	0.59	High
L-5	34%	64%	0.53	High
H-2	30%	70%	0.43	Moderate
L-3	26%	72%	0.36	Moderate
H-1	25%	75%	0.33	Moderate
H-4	21%	64%	0.33	Moderate
L-6	16%	84%	0.19	Low
H-6	13%	85%	0.15	Low
H-5	10%	90%	0.11	Low

Transactivity

In expected collaborative situations, all group members actively suggest their ideas and construct perceptions based on each other's ideas. In these situations, large percentage of discussions are high-level in terms of transactivity. Whereas in the opposite situations, ideas usually come from a single group member and are simply adopted by the group without any discussion. In these situations, most of discussions happened are low-level in terms of transactivity. In this study, the overall transactivity level of groups' planning discussions were evaluated based on the percentage of high-level planning discussion episodes emerged across two sessions in collaboration.

As stated in the coding scheme of transacitivity, planning discussion episodes were coded as 'Moderate' on transactivity if "ideas were suggested by multiple group members and were discussed, compared or extended by others". In other words, being coded as 'Moderate' indicates that at least some negotiations happened between groups members before coming to a final

answer, which can be considered as the bottom line of ‘being transactive’. Therefore, in order to evaluate the overall transactivity level of all planning discussions emerged in a group, the percentage of planning discussion episodes being coded as ‘Moderate’ or higher than ‘Moderate’ (‘Somewhat High’ and ‘High’), were reported to indicate the transactivity of planning discussions.

Overall, findings indicated that groups tended to engage in low-level planning discussions with most of their discussions being coded as ‘Low’ or ‘Somewhat Low’ in transactivity (see Table 11). Specifically, nine out of twelve groups had more than 80% of their planning discussions being ‘Low’ or ‘Somewhat Low’ in terms of transactivity level, and only one group slightly involved in the high level planning discussions in terms of transactivity (coded as ‘High’). A median-split strategy was used here in order to classify groups’ overall transactivity level of planning discussions. Relatively speaking, Group H2, H3, H4, L1, L4, and L5 were identified as ‘High’ in transactivity with the percentage of planning discussions being coded as ‘Moderate’, ‘Somewhat High’, and ‘High’ in transactivity higher than the other six groups; whereas group H1, H5, H6, L2, L3, and L6 were identified as ‘Low’ in transactivity with the percentage of planning discussions being coded as ‘Moderate’, ‘Somewhat High’, and ‘High’ in transactivity lower than the other six groups.

Table 11
Transactivity of Planning

Group	Transactivity Level					Combined Percentage of Moderate, Somewhat High, or High-level Planning Discussions	**Transactivity**
	Low	Somewhat Low	Moderate	Somewhat High	High		
L-4	32%	26%	37%	5%	/	42%	High
L-5	50%	17%	25%	8%	/	33%	High
H-3	25%	50%	8%	8%	8%	25%	High
H-2	54%	27%	19%	/	/	19%	High
H-4	48%	33%	15%	4%	/	18%	High
L-1	56%	28%	6%	11%	/	17%	High
H-6	71%	21%	7%	/	/	12%	Low
L-6	52%	36%	12%	/	/	12%	Low
H-1	52%	37%	11%	/	/	11%	Low
L-2	58%	33%	8%	/	/	8%	Low
H-5	25%	75%	/	/	/	0%	Low
L-3	50%	50%	/	/	/	0%	Low

Quality of Planning Discussions

Based on the coding and scoring results of groups' planning discussions on each planning indicator (*Occurrence features*, *Regulation Targets*, and *Transactivity*), the overall rating of the quality of planning discussions was generated for each group.

As showed in Table 12, the ratings of the overall quality of planning discussions were generalized from the evaluation on planning indicators. For example, compared to Group L6, rated as 'Acceptable' in terms of quality, group H1 was rated as 'Low' since their planning discussions were delayed in terms of timing, brief in terms of average length, moderately low on constructivity, and low-level in terms of building on each other's idea, summarized in the table as '*Not adequate, delayed and not meaningful*'.

In conclusion, group H3 and L3 were evaluated as having the best quality of planning discussions, compared to other groups; group H2 and L5 were evaluated as High on quality of

planning discussions; group H4, L1 and L6 were evaluated as acceptable on quality; and lastly, group H1, H5, H6, L2, and L3 were evaluated as Low on quality.

Table 12
Quality of Planning Discussions

Group	Occurrence Features			Regulation Targets (Constructivity)	Transactivity	Quality of Planning Discussions	Comment
	Planning Quantity	Timing	Average Length				
H3	High	Proactive	Lengthy	High	High	**Best**	Adequate and meaningful
L4	High	Proactive	Lengthy	High	High	**Best**	Adequate and meaningful
H2	High	Proactive	Lengthy	Moderate	High	**High**	Adequate and somewhat meaningful
L5	Moderate	Proactive	Moderate	High	High	**High**	Not adequate but meaningful planning
H4	High	Proactive	Moderate	Moderate	High	**Acceptable**	Adequate and somewhat meaningful, not in-depth
L1	Moderate	Proactive	Moderate	High	High	**Acceptable**	Not adequate, somewhat meaningful and focused on the right targets
L6	High	Proactive	Moderate	Low	Low	**Acceptable**	Adequate however not meaningful
H1	Moderate	Reactive	Brief	Moderate	Low	**Low**	Not adequate, delayed and not meaningful
H5	Low	Negligible	Moderate	Low	Low	**Low**	Hardly engaged in planning
H6	Low	Reactive	Brief	Low	Low	**Low**	Delayed, not adequate, and not meaningful
L2	Moderate	Proactive	Moderate	High	Low	**Low**	Focused on the right targets, but not in-depth and no interactions in the group
L3	Moderate	Proactive	Brief	Moderate	Low	**Low**	Not in-depth, and no interactions in the group

Part 3. Exploring how the quality of planning discussions contribute to group performance and planning challenge perceptions, under the three different planning support conditions.

RQ1. How does the quality of planning discussions differ among groups who reported problematic planning and groups who reported non-problematic planning??

First, regarding the overall quality of planning discussions, Table 13 reports the number of groups in each level of planning quality by planning challenge perceptions. The findings indicate that the actual observed quality of planning discussions and group reported planning challenges were not well-calibrated. In other words, when members of a group largely report that planning challenges had a big impact on their collaboration process, it's not necessarily reflected in the observed quality of their planning discussions. In contrast, when low-quality planning processes were observed in the discussion, groups may still have reported that planning challenges were not a big problem to their collaboration.

Table 13

Number of Groups Perceived Planning Problematic/Non-problematic by Observed Quality of Planning Discussions

Quality of Planning Discussions	**Perceptions of Planning Challenge**	
	Problematic	Non-problematic
Best	1	1
High	1	1
Acceptable	1	2
Low	3	2

In order to get a deeper understanding of the difference in the planning process, planning indicators were compared respectively with group reported planning challenges (See Table 14). Among groups that reported planning problematic, three groups engaged in large amounts of planning discussions, one group engaged in moderate amount of planning discussions, and two groups engaged in a small amount of planning discussions. For groups who reported planning non-problematic, two groups engaged in large amount of planning discussions and four groups

engaged in moderate amount of planning discussions, no group had low amount of planning discussions. In general, groups who reported planning problematic, had varied characteristics in terms of planning quantity; whereas groups who reported planning non-problematic, were likely to have had more planning discussions.

Table 14
Number of Groups Reporting Planning Problematic/Non-problematic by Planning Quantity

	Perceptions of Planning Challenge	
Planning Quantity	Problematic	Non-problematic
High	3	2
Moderate	1	4
Low	2	0

Regarding to the timing of major planning (showed in Table 15), groups who reported planning problematic had varied kind of planning pattern: three groups engaged in proactive planning, two groups engaged in reactive planning, one group had limited planning discussions that they could neither be classified as proactive or reactive. In contrast all the groups reporting planning non-problematic, engaged in proactive planning meaning that they did a substantial amount of their planning discussions during the group planning meeting rather than leaving it until they were engaged in the timed collaborative task working session.

Table 15
Number of Groups Reporting Planning Problematic/Non-problematic by Planning Pattern (Timing of Major Planning)

	Perceptions of Planning Challenge	
Planning Pattern (Timing of Major Planning)	Problematic	Non-problematic
Proactive Planning	3	6
Reactive Planning	2	0
Negligible	1	0

For the average length of planning discussions (showed in Table 16), groups who reported planning problematic seemed to have varied length of planning discussions. However, groups

who reported planning non-problematic tended to have relatively moderate length of planning discussions with four out of six groups fall under ‘Moderate’.

Table 16
Number of Groups Reporting Planning Problematic/Non-problematic by Average Length of Planning Discussions

Average Length of Planning Discussions	Perceptions of Planning Challenge	
	Problematic	Non-problematic
Lengthy	2	1
Moderate	2	4
Brief	2	1

As demonstrated in Table 17, groups who reported planning problematic seemed to have varied constructivity levels. Whereas groups who reported planning non-problematic tended to have more planning discussions focused on constructing planning knowledge with four out of six groups being identified as ‘High’ on constructivity.

Table 17
Number of Groups Reporting Planning Problematic/Non-problematic by Regulation Targets (Constructivity)

Regulation Targets (Constructivity)	Perceptions of Planning Challenge	
	Problematic	Non-problematic
High	1	4
Moderate	3	1
Low	2	1

Finally, as shown in Table 18, transactivity level did not seem to differ between groups who reported planning problematic and groups who reported planning non-problematic.

Table 18
Number of Groups Reporting Planning Problematic/Non-problematic by Transactivity

Transactivity	Perceptions of Planning Challenge	
	Problematic	Non-problematic
High	3	3
Low	3	3

Conclusion. First of all, for groups who reported planning non-problematic, they tend to have more planning discussions, moderate length conversations, more planning at the early stage of collaboration, and more planning statements focused on constructing planning knowledge. As for groups who reported planning problematic, the characteristics of their planning discussions are varied in terms of planning quantity, timing of major planning, average length of planning discussions, regulation targets, and transactivity. In general, the observed overall quality of groups' planning discussions does not seem well-calibrate with groups' perceptions of planning challenge.

RQ2. How does the Quality of Planning Discussions Differ among Groups Who Received Different Conditions of Group Awareness Support?

As demonstrated in Table 19, most importantly, for groups who received nominal visualization support, all groups showed at least '*High*' quality planning discussions during the collaboration task (With two groups had *Best* planning and two groups had *High* planning regarding to quality). However, the other type of visualization support did not seem to have an effect on groups' planning quality: For groups who received quantified visualization support, planning quality was more varied with one group being classified as '*Best*' quality of planning, one group showed '*Acceptable*' quality of planning, and two groups showed '*Low*' quality planning. Lastly, for groups who received no visualization support, two out of five groups had '*Acceptable*' quality of planning and the remaining three groups only had '*Low*' quality planning in the collaboration challenge.

Table 19
Number of Groups Received No/Quantified/Nominal Visualization by Quality of Planning Discussions

Quality of Planning Discussions	Conditions of Group Awareness Tool in the Form of Visualization		
	No	Quantified	Nominal
Best	0	1	1
High	0	0	2
Acceptable	2	1	0
Low	3	2	0

Planning indicators were compared with visualization conditions to investigate how exactly does planning differs across groups who received different conditions of visualization support.

For planning quantity (Table 20), the nominal visualization support seems to be effective in terms of stimulating planning discussions with all the three groups in this condition had at least moderate amount of planning discussions, and two of them engaged in large amount of discussions. On the other hand, the quantified visualization support does not seem to have a clear influence on groups' planning quantity with two groups engaged in large amount of planning discussions, one group engaged in moderate amount of planning discussions and the rest group engaged in low amount of planning discussions. Additionally, groups who received no visualization support also shows varied results in terms of planning quantity.

Table 20
Number of Groups Received No/Quantified/Nominal Visualization by Planning Quantity

Planning Quantity	Conditions of Group Awareness Tool in the Form of Visualization		
	No	Quantified	Nominal
High	1	2	2
Moderate	3	1	1
Low	1	1	0

As for the indicator of Timing, groups receiving nominal visualization support all engaged in proactive planning with the majority of planning discussions occurring during the

group planning meeting. Yet groups receiving no visualization and groups receiving quantified visualization had similar results in terms of timing of major planning: In both conditions, one group had reactive planning and three groups had proactive planning (see Table 21).

Table 21
Number of Groups Received No/Quantified/Nominal Visualization by Timing of Major Planning

Planning Pattern (Timing of Major Planning)	**Conditions of Group Awareness Tool in the Form of Visualization**		
	No	Quantified	Nominal
Proactive	3	3	3
Reactive	1	1	0
Negligible	1	0	0

Regarding to the average length of planning discussion (Table 22), the support of nominal visualization also seemed to be effective since two out of three groups that received this kind of support engaged in 'Lengthy' planning discussions, and no group with this support engaging in brief planning discussions. Additionally, no clear evidence suggests that quantified visualization has an effect on groups planning discussions in terms of the average length.

Table 22
Number of Groups Received No/Quantified/Nominal Visualization by Average Length of Planning Discussion

	Conditions of Group Awareness Tool in the Form of Visualization		
Average Length	No	Quantified	Nominal
Lengthy	0	1	2
Moderate	4	1	1
Brief	1	2	0

Similarly, only the support of nominal visualization seemed to influence planning discussions in terms of regulation targets (see Table 23). Two out of three groups receiving nominal visualization support focused on constructing planning knowledge and no groups in this condition were 'Low' in constructivity. This finding did not carry over to groups receiving quantified visualization planning support.

Table 23
Number of Groups Received No/Quantified/Nominal Visualization by Regulation Targets (Constructivity)

Regulation Targets (Constructivity)	Conditions of Group Awareness Tool in the Form of Visualization		
	No	Quantified	Nominal
High	2	1	2
Moderate	2	1	1
Low	1	2	0

Finally, for transactivity level (Table 24), all the three groups that received nominal support were identified as being high on transactivity level. Evidence did not carry forward to groups receiving quantified visualizations to support planning.

Table 24
Number of Groups Received No/Quantified/Nominal Visualization by Transactivity

	Conditions of Group Awareness Tool in the Form of Visualization		
Transactivity	No	Quantified	Nominal
High	2	1	3
Low	3	3	0

RQ3. Are the Quality of Groups' Planning Discussions, and Groups' Perceptions of Planning Challenge, Associated with Their Performance on the Collaboration Task?

Group Performance and Perceptions of Planning Challenges

First, groups' performance (institutional grade) on the collaborative task was compared with their perceptions of planning challenges. As demonstrated in Table 25, five out of six groups that reported planning problematic performed low on the collaboration task, and five out of six groups that reported planning non-problematic performed high on the task. This result indicates that perceptions of planning challenges at the group level might be associated with group performance on the collaborative task.

Table 25
Number of Groups Performed High/Low on the Collaboration Challenge by Perceptions of Planning Challenges

	Group Performance on the Collaboration Task	
Perceptions of Planning Challenges	High	Low
Problematic	1	5
Non-problematic	5	1

Group Performance and Quality of Planning Discussions

According to the results showed in Table 26, no evidence suggest that the quality of planning discussions was directly associated with the final group performance on the collaboration task.

Table 26
Number of Groups Received High/Low Grade on the Collaboration Challenge by Planning Quality

Quality of Planning Discussions	Group Performance on the Collaboration Task	
	High	Low
Best	1	1
High	1	1
Acceptable	1	2
Low	3	2

Group Performance and Received Visualization Condition

Similarly, as showed in Table 27, no evidence suggest that the group received support condition (visualization) is directly associated with the final group performance on the collaboration task.

Table 27
Number of Groups Received High/Low Grade on the Collaboration Challenge by Visualization Support Condition

	Group Performance on the Collaboration Task	
Support Condition (Visualization)	High	Low
No	2	3
Quantified	3	1
Nominal	1	2

Chapter 5: Discussion

The purpose of this qualitative case comparison study was to explore how the quality of planning discussions contribute to group performance and planning challenge perceptions, under the three different planning support conditions. This chapter presents discussions of findings and implications for future research and practice.

Corresponding to the results chapter, the discussion is organized in two sections. First, the overall findings across groups in terms of major challenges reported about collaboration and descriptive findings based on coding results of planning indicators are discussed. Second, findings of the research questions are reviewed and discussed.

The essential role of group planning was largely neglected. As for the general planning process, groups tended to assign planning questions (provided during the group planning meeting) to individuals to gain quick answers, rather than discussing planning issues collectively. In the present study, students were enrolled in a course that consistently stressed the importance of learning how to collaborate, including the essential step of group planning in collaboration. However, many groups still chose to quickly complete the session by having individual group members finish the questions alone. In other words, groups tended to neglect the essential role of group planning, including generating shared perceptions of the task, common goals & plans. Previous research and practice have found that groups engaged in collaborative tasks tend to skip planning and jump right into the task working-session, especially when time is pressing for the task (Volet, Summers, & Thurman, 2009; Hadwin, 2007). Despite that, during the sampling process of the current study, when groups were selected based on group members' reports on major challenges, we noticed that among all 187 students who submitted a reflection report, not a single student reported '*Constructing or aligning accurate perceptions of the task, identifying*

goals and priorities, planning strategies or approaches' as their major challenges. This may also suggest that the core ideas of planning were largely neglected by individuals and groups.

The analysis of the groups' planning discussions revealed that:

Having sufficient amount of planning discussions is a precondition for effective planning. Under the computer-supported collaborative learning environment, students collaborated by text chat in a chat channel and changes to a shared planning document. It was impossible for group members to plan together when nothing was posted in the chat box. Early research found that the effectiveness of collaborative learning largely depends on the richness and intensity of interactions engaged in by group members during collaborative processes (Dillenbourg, 1996). Among the selected learning groups, two groups engaged in very limited amount of planning discussions across the two stages in collaboration, and these group did not have many chances to talk about planning issues, listen to other members' opinions, or build any planning knowledge during the process.

Not all groups optimized planning opportunities at the group planning meeting even with prompts. Planning timing was not initially identified as a planning quality measure, since we assumed that the majority of planning discussions would naturally happen during the group planning meeting when groups were assigned the task of planning and essential planning questions were provided to assist with the planning process. However, the results of the current study do not support this assumption because two out of 12 groups had the majority of their planning discussions emerged in the later collaborative working session. Past research has found that group members who engage in high-quality planning in the early stages of collaboration perform better and construct better mental models in the task (Stout et al., 1999). Besides the essential planning issues that require group members' early efforts, grasping the chance to build

familiarity with other members is also essential since ad hoc learning groups are often initially ineffective due to the absence of mutual trust and necessary information about other's competencies and behaviours (Fransen et al., 2013).

Most learning groups tended to focus on task completion rather than knowledge construction in the regulation of planning. The analysis of groups' regulation targets in planning discussions revealed that groups tended to direct most of their attention to procedural planning such as deciding the functional role for the task. In contrast, little attention was given to constructing planning knowledge such as generating aligned task understandings. Similar findings were reported in other studies: Volet, Summers, and Thurman (2009) found that group members did not fully engage in learning processes, and instead, mainly focused on task completion. Similarly, Shukor and colleagues (2014) investigated twenty university students' knowledge construction strategies when enrolled in web-based authentic group activities. They reported that students generally posted messages at low-level of knowledge construction. Specifically, more than half of their postings in conversations were simply pasting information directly from resources and such, rather than constructing new knowledge. It is noted that these studies were focused on knowledge construction in the task domain area, whereas the present study focused on knowledge construction in terms of planning knowledge and similarly found that the process of knowledge construction is neglected by groups.

Groups tend to engage in low-level planning discussions in terms of building on each other's ideas. In the present study, a median-split strategy was used to classify relatively high- and low-level discussions in terms of building on each other's ideas. However, as reported in the results chapter, high transactivity planning was rare across all groups. For example, only one group engaged in small amount (8%) of *High* transactivity planning across all stages. This

general deficiency in transactivity was caused by two dominant collaborative practices: 1) most groups assigned planning questions to individuals who decided the answers by themselves, and 2) groups largely focused on completing the planning questions rather than leveraging planning questions to generally prepare for the task. This typically resulted in groups adopting individuals' planning answers limited to know planning discussion amongst team members. Nevertheless, having all the planning questions completed did not mean the latent planning challenges were tackled, since group members did not reach an agreement on the answers during this process, or even have a chance to share their opinions. As reported in Rimor, Rosen, and Naser's study (2010), students tended to interact at the level of reaching rapid consensus, but rarely to the level of discussing issues. Although frequent interactions happened between group members to regulate each other's cognition and behavior, only low-level strategies were adopted. For example, groups adopted practices such as taking over a functional role without giving explanations, providing a quick reminder to re-engage in the task, or simply repeating some information mentioned earlier. In general, these regulation processes were largely low-level and did not serve to ameliorate challenges. Similar patterns were reported in Kempler and Linnenbrink-Garcia's study (2007) and DiDonato's study (2013).

RQ1-How does the quality of planning discussions differ among groups who reported problematic planning and groups who reported non-problematic planning?

The overall quality of groups' planning discussions was not calibrated with their self-assessments regarding the reported planning challenges encountered by the group. First, the observed planning quality did not match with the groups' perceptions of planning challenges. That is, groups who believed their planning was not a big problem in collaboration may have low

quality planning processes; whereas groups who believed their collaboration was largely affected by planning challenges may, indeed, have high-quality planning processes. Volet, Summers, and Thurman (2009) investigated co-regulation in collaborative learning among students who engaged in student-led activities in university and found that most groups (five out of six) mainly dealt with other matters rather than processing the task and organization when all the groups reported high-level satisfaction with their groups' performance. The authors suggest that university students may not be well versed about the most effective forms of collaborative learning, and therefore, tend not to report problems when the actual processes are low-level in terms of quality.

In general, we assume that there may be three reasons for the inconsistency between groups' perceptions and their observed behaviors. First, groups may not be familiar with highly effective planning processes in collaboration, and therefore, their reports on how planning processes had affected their collaboration process were not accurate. Second, group members did not realize root problems regarding planning. For instance, group members simply reported time-related challenges (e.g., 'Trouble with running out of time') when they realized that the task was pressing for time. However, the root problem of how their planning processes ended like this was not noticed (i.e., unequal commitment to the task, not-all-agreed goals and plans, or different ideas about how to organize time). And third, the reported problematic planning processes may be their reflections of the earlier processes, which were realized and improved at a later stage. Thus, the observed planning processes turned out to have a decent quality level.

In terms of specific planning indicators, groups who reported planning non-problematic tended to engage in proactive planning, have more planning discussions, and focus more on planning knowledge construction. In general, groups who reported planning

non-problematic performed better in terms of *planning quantity*, *timing*, and *regulation target*. These findings suggest that when groups engage in lots of planning discussions, have planning issues tackled early, and pay lots of attention on constructing planning knowledge, they tend to generate more positive perceptions and experience about planning in collaboration. However, the relevance was not found in the indicators of *average length* and *transactivity* level of planning discussions. Both the *Transactivity* and the *Average Length* more or less measure the depth of groups' interactions when tackling planning problems, however, it does not seem to play a big role in terms affecting students' perceptions of planning challenges. One possible interpretation if this finding is that, compared to discussing the planning content in-depth, maintaining the ongoing planning process and focusing on the right targets contributes more to groups' experience with planning, consider that maintaining the planning process was already hard for groups. In other words, maintaining high transactivity is needed for planning interactions, but may not be a necessity for all the planning discussions since the more crucial part is to focus on the right topic first. Another possible reason is that the range of groups selected in the current study was not wide enough since most groups only engaged in low-level planning discussions in terms of building on each other's ideas.

RQ2-How does the quality of planning discussions differ between groups who received different conditions of planning support (group awareness tool)?

In general, groups who received nominal visualizations engaged in more powerful planning processes during collaboration. The results showed that groups who received group awareness tool in the form of nominal visualizations of group members' planning perceptions demonstrated relatively higher planning quality in collaboration; whereas groups who received quantified visualization revealed varied results in terms of planning quality and does not seem to

differ so much from the groups who received no visualization support. Starcheski and colleagues investigated groups' regulation processes under different conditions of planning support. The findings also suggest that groups who received nominal (graphic) visualizations were more active (involved in more planning discussions) in planning, compared to groups who received no visualization. However, the difference between the two types of visualization (numeric/non-numeric graphic) was not found. Similarly, Hadwin et al. (2018) examined the reported challenges and the effectiveness of strategies that individuals adopted during collaboration when different types of visualizations were provided to groups. Their findings suggest that groups who received visualization support (either nominal or quantified) reported planning as less problematic and reported higher levels of success with strategy use in collaboration. Furthermore, Hadwin et al., found no difference between the two types of visualizations. In contrast, findings from the current study shows that the quantified visualization was not so influential, compared to the nominal visualization support. Consider the difference between the two types of visualizations, quantified visualization provides more information with the number of students who selected the same options displayed to group members. Thus, it is assumed that providing too much information to group members may not be beneficial, since it may decrease the possibility of planning discussions within groups when particular options were selected too frequently, or not chosen. For example, if one option was selected by three out of four members in a group (or not chosen at all), they may simply adopt that option (or simply ignore the option) without engaging in any further discussions. A similar phenomenon was also reported in Hadwin and Miller's (2015b) study when individual planning support (high vs. low) and group planning tool (high vs. low) were both provided to group members, however, the study reported that when

high-level individual support and high-level group planning support were both provided to students, groups' planning processes, however, were not enhanced.

The effect of nominal visualizations, in particular, was also found in the examination of each planning indicator. That is, groups who received group awareness tool in the form of nominal visualization had better planning regarding planning quantity, timing, average length, regulation targets, and transactivity level. These consistent findings all suggest the positive role that nominal visualization played in terms of supporting the group planning process in collaboration.

RQ-3 Is group performance on the collaboration task associated with groups' planning quality and group perceptions of planning challenge?

Group perceptions of planning challenges were found to be associated with their final performance on the task. As reported in the findings of the present study, groups who reported experiencing non-problematic planning processes in collaboration tend to have better learning outcomes in terms of group performance on the task, whereas groups who reported experiencing problematic planning processes tend to have lower group grade on the group collaboration task. Although students' perceptions are influenced by multiple factors and research suggests that students' perceptions of their collaboration process are not always accurate, these findings still indicate that group members' self-report experience on planning challenges, to a certain extent, reflects the final learning outcomes. In other words, when group members perceived planning problematic, which largely affected their collaboration process, it may indicate that their group performance on the collaboration task was affected. The explanation is that when high-level planning challenges are reported by groups, it usually suggests that the group met major

challenges at the beginning stage of the task, given that the task was designed to be difficult and time pressing, when these planning challenges were not tackled well, or the group didn't regain its morale affected by the challenge, it would largely affect the learning outcomes. It will be valuable for future research to compare the associations between perceptions of different types of challenges and the final learning outcomes.

We did not find performance difference between groups who had relative high-quality planning and groups who had low-quality planning. This may due to two reasons: First, although the groupings in the current study attempted to maximize heterogeneity based on language proficiency, previous quiz performance, academic major, and gender, there are still plenty of individual characteristics and group characteristics which were not controlled, such as preparations before the task, individual expertise, cultural background, and group atmosphere; second, there might unknown intermediate variables between the planning quality and the final learning outcomes; Second, extreme case sampling was used to distinguish groups who reported planning problematic/non-problematic, and therefore, the overall amount of sample groups was not huge, and the range of groups' planning qualities was limited. Additionally, future studies may consider examining the effect of planning support tools on the learning outcomes of knowledge construction.

As for planning support conditions, although nominal visualizations have been found effective in improving planning processes, findings from this study suggest that simply providing planning supports to groups is not enough to lead to differences in final learning outcomes in terms of the collaborative group performance.

Implications for research and practice

Implications for research. This study contributes to research within the field of CSCL in several ways. First, previous studies usually focus on knowledge construction activities in the task domain area, such as examining whether the course objectives have been met or not during collaborative learning. Whereas in the current study, we focused on knowledge construction in terms of planning knowledge such as whether groups have paid their attention on sharing their own understandings of the task requirements, or what are the most important things in terms of preparing for the coming working session.

Second, different from previous studies that collected students' reflections on challenges in collaboration at the individual level and their effect on collaborative outcomes, this study preserves the groups as a unit when recognizing the perceptions of planning challenges, as well as the quality of planning processes and learning outcomes. Research indicates that studies that focus on group discussions and investigate the group variables holistically can provide new insights about why some discussions are better than others in terms of generating opportunities for knowledge construction (Barron, 2003).

Third, this explorative study examined five planning indicators (including planning quantity, timing, average length, regulation targets, and transactivity) and compared them with groups' perceptions of challenges and the received planning conditions. Additionally, the overall qualities of planning discussions were also summarized. Some indicators were measured in previous studies of conversation patterns such as planning quantity and transactivity, and some indicators were newly proposed such as the timing of major planning. These planning indicators may not be sufficient to cover the full picture of groups' planning processes, however, it still provides some insights into measuring the major characteristics and qualities of the regulation process of planning.

Implications for practice. The findings of the current study can be used to inform future educational practices. First, the findings suggest that students in university may not be familiar with highly effective planning processes and how it could boost the collaboration process and outcomes. Even with planning support tools provided to guide the group planning meeting, groups simply skipped the process and did not take the chance to plan. With this regard, educators need to find ways to encourage groups to try engaging in a fulsome planning processes and discussions and furthermore understanding how it could help with collaborative learning. What's more, the reported major challenges suggest that individual learners and groups may not be trained in terms of recognizing the root challenges which affected their learning process.

Second, although the regulation of planning in groups need to be processed in-depth, educators need to first encourage groups to engage in sufficient amount of planning discussions, given the finding that planning quantity plays a big role in terms of affecting the overall planning quality, and is directly associated with groups' perceptions of encountered planning challenges during collaboration.

Third, although no difference was found on group performance across different planning support conditions, the group awareness tool of nominal visualizations was found effective in terms of promoting planning discussions. Educators and learners may consider utilizing this kind of planning support in future educational scenarios to help groups engage in highly effective planning discussions.

Conclusions

This thesis targeted at contributing to a larger project: Adaptive Regulation for 21st Century Success (PAR-21) from the aspect of how technologies of planning support promote the

planning process in particular. With this regard, this study drew on theories of learning science and research about CSCL environments to investigate the role of quality of planning discussions emerged in collaborative learning and how it contributes to group performance and planning challenge perceptions under group awareness support. Results suggest that groups generally engaged in low-quality planning discussions and were not calibrated with groups' perceptions of how much planning challenges had affected their collaboration process. Furthermore, the group awareness tool in the form of nominal visualizations was found to be effective in terms of promoting the quality of planning discussions. Lastly, it is found that group perceptions of planning challenges are associated with final group performance on the collaboration task.

Recommendations for Supporting Effective Online Collaborative Learning

Findings from the present study point to three recommendations for supporting effective online collaborative learning, particularly in post-secondary contexts. These recommendations are particularly salient during the COVID 19 pandemic when learning to work and collaborate online has become an essential skill. First, the essential role of planning needs to be emphasized and supported to students prior to beginning collaborative task work. Findings from this study revealed that planning was underemphasized by individual learners and learning groups. Second, instructors need to intentionally assign planning and create room and space for groups to engage in planning. Despite the importance of planning for successful collaboration, it doesn't always happen organically. Groups may neglect planning for many reasons such as time, knowledge of how to plan effectively, or lack of understanding about how fundamental it is for effective collaboration. Prompting intentional collaborative planning sets the stage for effective collaboration and also creates opportunities for groups to build relationships before getting into task work. During COVID 19, these kinds of online meetings may be the only opportunities for

students to meet and communicate with their peers. Third, instructors need to intentionally foster the environment in which planning interactions (about task understandings, plans, and goals) can happen. For example, instructors could ask students who hold competing views about the task to communicate with each other about their interpretations (scripting tool) or provide opportunities for group members to see each other's interpretations of the task as well as goals and plans (generating group awareness).

References

Andersson, A., Hatakka, M., Grönlund, Å., & Wiklund, M. (2014). Reclaiming the students–coping with social media in 1: 1 schools. *Learning, Media and Technology*, *39*(1), 37-52.

Bakhtiar, A., & Hadwin, A. F. (2020). Dynamic Interplay between Modes of Regulation during Motivationally Challenging Episodes in Collaboration. *Frontline Learning Research*, *8*(2), 1-34.

Bakhtiar, A., Webster, E. A., & Hadwin, A. F. (2018). Regulation and socio-emotional interactions in a positive and a negative group climate. *Metacognition and Learning*, *13*(1), 57-90.

Barron, B. (2003). When smart groups fail. *Journal of the Learning Sciences*, *12*(3), 307-359.

Binkley, M., Erstad, O., Herman, J., Raizen, S., Ripley, M., Miller-Ricci, M., & Rumble, M. (2012). Defining twenty-first century skills. *In Assessment and teaching of 21st century skills* (pp. 17-66). Springer, Dordrecht.

Bodemer, D., & Dehler, J. (2011). Group awareness in CSCL environments. *Computers in Human Behavior*, *27*(3), 1043-1045.

Boekaerts, M. (1992). The adaptable learning process: initiating and maintaining behavioural change. *Appl. Psychol. 41*, 377–397.

Boekaerts, M. (1996). Self-regulated learning at the junction of cognition and motivation. *Eur. Psychol. 2*, 100–112.

Bryan, J. F., & Locke, E. A. (1967). Goal setting as a means of increasing motivation. *Journal of Applied Psychology*, *51*, 274–277.

Butler, D. L., & Cartier, S. C. (2004). Promoting effective task interpretation as an important work habit: A key to successful teaching and learning. *Teachers College Record*, *106*(9), 1729–1758.

Csanadi, A., Eagan, B., Kollar, I., Shaffer, D. W., & Fischer, F. (2018). When coding-and-counting is not enough: using epistemic network analysis (ENA) to analyze verbal data in CSCL research. *International Journal of Computer-Supported Collaborative Learning*, *13*(4), 419-438.

De Lisi, R., & Golbeck, S. L. (1999). Implications of Piagetian theory for peer learning. In A. M. O'Donnell & A. King (Eds.), *The Rutgers Invitational Symposium on Education Series. Cognitive perspectives on peer learning* (pp. 3-37). Mahwah, NJ, US: Lawrence Erlbaum Associates Publishers.

Dewiyanti, S., Brand-Gruwel, S., Jochems, W., & Broers, N. J. (2007). Students' experiences with collaborative learning in asynchronous computer-supported collaborative learning environments. *Computers in Human Behavior*, *23*(1), 496-514.

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

Dillenbourg, P., & Hong, F. (2008). The mechanics of CSCL macro scripts. *International Journal of Computer-Supported Collaborative Learning*, *3*(1), 5-23.

Dillenbourg, P., Baker, M., Blaye, A., & O'Malley, C. (1996). The evolution of research on collaborative learning In H. Spada and P. Reimann (Eds) *Learning in Humans and Machines* (pp. 189-211). Oxford, UK: Elsevier.

Dillenbourg, P., Järvelä, S., & Fischer, F. (2009). The evolution of research on computer-supported collaborative learning. *In Technology-enhanced learning* (pp. 3-19). Springer, Dordrecht.

Efklides, A. (2011). Interactions of metacognition with motivation and affect in self-regulated learning: the MASRL model. *Educ. Psychol. 46*, 6–25.

Greene, J. A., Hutchison, L. A., Costa, L. J., & Crompton, H. (2012). Investigating how college students' task definitions and plans relate to self-regulated learning processing and understanding of a complex science topic. *Contemporary Educational Psychology, 37*(4), 307-320.

Hadwin, A. F. (2017, August). *Promoting adaptive regulation*. Keynote at the European Association for Research on Learning and Instruction, Tampere, Finland. Retrieved from https://youtu.be/DHD8loVaTQI

Hadwin, A. F., & Oshige, M. (2011). Self-regulation, co-regulation, and socially shared regulation: Exploring perspectives of social in self-regulated learning theory. *Teachers College Record, 113*(6), 240–264.

Hadwin, A. F., Bakhtiar, A., & Miller, M. (2018). Challenges in online collaboration: effects of scripting shared task perceptions. *International Journal of Computer-Supported Collaborative Learning*, *13*(3), 301-329.

Hadwin, A. F., Järvelä, S., & Miller, M. (2011). Self-regulated, co-regulated, and socially shared regulation of learning. In B. J. Zimmerman, & D. H. Schunk, (Eds.), Handbook of self-regulation of learning and performance (pp. 65–84). New York, NY: Routledge.

Hadwin, A., Järvelä, S., & Miller, M. (2018). Self-regulation, co-regulation, and shared regulation in collaborative learning environments. In D. Schunk, & J. Greene, (Eds.). *Handbook of self-regulation of learning and performance* (2nd ed.). New York, NY: Routledge.

Hadwin, A.F., Webster, E., Bakhtiar, A., & Caird, H. (2015). Challenges in Teamwork: Examining the effects of 4 different planning scripts. Paper presented at the European Association for Research on Learning and Instruction, Limassol, Cyprus.

Isohätälä, J., Järvenoja, H., & Järvelä, S. (2017). Socially shared regulation of learning and participation in social interaction in collaborative learning. *International Journal of Educational Research, 81*, 11-24.

Jamieson-Noel, D. L. (2005). Exploring task definition as a facet of self-regulated learning. *Dissertation Abstracts International Section A: Humanities and Social Studies, 66*(6-A), 2102.

Janssen, J., Erkens, G., Kirschner, P. A., & Kanselaar, G. (2012). Task-related and social regulation during online collaborative learning. *Metacognition and Learning, 7*(1), 25-43.

Järvelä, S., & Hadwin, A. F. (2013). New frontiers: Regulating learning in CSCL. *Educational Psychologist, 48*(1), 25–39.

Järvelä, S., Järvenoja, H., & Veermans, M. (2008). Understanding dynamics of motivation in socially shared learning. *International Journal of Educational Research, 47*, 1, 122–135.

Järvelä, S., Malmberg, J., & Koivuniemi, M. (2016). Recognizing socially shared regulation by using the temporal sequences of online chat and logs in CSCL. *Learning and Instruction, 42*, 1-11.

Järvenoja, H., & Järvelä, S. (2009). Emotion control in collaborative learning situations: Do students regulate emotions evoked by social challenges. *British Journal of Educational Psychology 79*(3), 463-481.

Kapur, M. (2011). Temporality matters: Advancing a method for analyzing problem-solving processes in a computer-supported collaborative environment. *International Journal of Computer-Supported Collaborative Learning*, *6*(1), 39-56.

Leinonen Määttä, E., Järvenoja, H., & Järvelä, S. (2012). Triggers of students' efficacious interaction in collaborative learning situations. *Small Group Research, 43*(4), 497-522.

Lincoln, Y. S., & Guba, E. G. (1986). But is it rigorous? Trustworthiness and authenticity in naturalistic evaluation. *New directions for program evaluation, 1986*(30), 73-84.

Miller, M., & Hadwin, A. (2015a). Scripting and awareness tools for regulating collaborative learning: Changing the landscape of support in CSCL. *Computers in Human Behavior, 52*, 573-588.Association for Research on Learning and Instruction, University of Munich, Germany.

Miller, M., & Hadwin, A. F (2015b). Investigating CSCL supports for shared task perceptions in socially shared regulation of collaborative learning. Manuscript in submission.

Miller, M., Malmberg, J. Hadwin, A., Jarvela, S. (2013). Tracing shared task perceptions in online collaboration. Paper presented at the annual conference of the European.

Noroozi, O., Biemans, H. J., Weinberger, A., Mulder, M., & Chizari, M. (2013). Scripting for construction of a transactive memory system in multidisciplinary CSCL environments. *Learning and Instruction, 25*, 1-12.

Panadero, E., & Järvelä, S. (2015). Socially shared regulation of learning: A review. *European Psychologist, 20*(3), 190–203.

Panadero, E., Kirschner, P. A., Järvelä, S., Malmberg, J., & Järvenoja, H. (2015). How Individual Self-Regulation Affects Group Regulation and Performance: A Shared Regulation Intervention. *Small Group Research, 46*(4), 431–454.

Partnership for 21st Century Learning (2007). Framework for 21st century learning. Retrieved from http://www. p21.org/about-us/p21-framework.

Pintrich, P. R. (2004). A Conceptual Framework for Assessing Motivation and Self-Regulated Learning in College Students. *Educational Psychology Review, 16*(4), 385–407.

Pintrich, P. R., and de Groot, E. V. (1990). Motivational and self-regulated learning components of classroom academic performance. J. *Educational Psychology. 82*, 33–40.

Popov, V., van Leeuwen, A., & Buis, S. C. A. (2017). Are you with me or not? Temporal synchronicity and transactivity during CSCL. *Journal of Computer Assisted Learning, 33*(5), 424-442.

Reimann, P. (2009). Time is precious: Variable-and event-centred approaches to process analysis in CSCL research. *International Journal of Computer-Supported Collaborative Learning*, *4*(3), 239-257.

Rimor, R., Rosen, Y., & Naser, K. (2010). Complexity of social interactions in collaborative learning: The case of online database environment. *Interdisciplinary Journal of E-Learning and Learning Objects*, *6*(1), 355-365.

Rogat, T. K., & Linnenbrink-Garcia, L. (2011). Socially shared regulation in collaborative groups: An analysis of the interplay between quality of social regulation and group processes. *Cognition and Instruction, 29*(4), 375-415.

Shukor, N. A., Tasir, Z., Van der Meijden, H., & Harun, J. (2014). Exploring students' knowledge construction strategies in computer-supported collaborative learning discussions using sequential analysis. *Journal of Educational Technology & Society*, *17*(4), 216-228.

Starcheski, S. J., Davis, S. K., Bakhtiar, A., Webster, E., Miller, M. F., & Hadwin, A. F. (2017). Processes and targets of regulation in online collaborative assignments. Paper presented as part of a symposium titled: *Promoting adaptive regulation in collaborative learning.* Canadian Society of Studies in Education (CSSE), Toronto, ON, May 30, 2017.

Stout, R. J., Cannon-Bowers, J. A., Salas, E., & Milanovich, D. M. (1999). Planning, shared mental models, and coordinated performance: An empirical link is established. *Human Factors, 41*(1), 61-71.

Teasley, S. D. (1997). Talking about reasoning: How important is the peer in peer collaboration? In L. B. Resnick (Ed.), *Discourse, tools and reasoning: Essays on situated cognition* (pp. 361-384). Berlin, Germany: Springer.

University of Victoria Calendar 2019-2020 (2019, September). Retrieved from the University of Victoria website: https://web.uvic.ca/calendar2019-09/pdfs/undergraduate-201909.pdf

Volet, S., Summers, M., & Thurman, J. (2009). High-level co-regulation in collaborative learning: How does it emerge and how is it sustained?. *Learning and Instruction, 19*(2), 128-143.

Webster, E. A., & Hadwin, A. F. (2019). Individual and group strategies for regulating emotions in online collaboration. Manuscript in preparation.

Weinberger, A., & Fischer, F. (2006). A framework to analyze argumentative knowledge construction in computer-supported collaborative learning. *Computers & education, 46*(1), 71-95.

Weinberger, A., Fischer, F., & Mandl, H. (2002). Fostering computer supported collaborative learning with cooperation scripts and scaffolds. In G. Stahl (Ed.), *Computer support for collaborative learning: Foundations for a CSCL community. Proceedings of the conference on computer support for collaborative learning* (pp. 573–574). Boulder, CO.

Weingart, L. R. (1992). Impact of group goals, task component complexity, effort, and planning on group performance. *Journal of applied psychology*, *77*(5), 682.

Weingart, L. R., & Weldon, E. (1991). Processes that mediate the relationship between a group goal and group member performance. *Human Performance*, *4*, 33–54.

Winne, P. H. (2014). Issues in researching self-regulated learning as patterns of events. *Metacognition and Learning, 9*(2), 229-237.

Winne, P. H., & Hadwin, A. (2008). The weave of motivation and self-regulated learning. In D. H. Schunk, B. J. Zimmerman (Eds.), Motivation and self-regulated learning: Theory, research and applications (pp. 298-314). New York: Lawrence Erlbaum.

Winne, P. H., Hadwin, A. F., & Perry, N. E. (2013). Metacognition and computer supported collaborative learning. In C. Hmelo-Silver, A. O'Donnell, C. Chan, & C. Chinn (Eds.), *International handbook of collaborative learning* (pp. 462–479). New York: Taylor & Francis.

Winne, P., & Hadwin, A. (1998). Studying as self-regulated learning. In D. J. Hacker, J. Dunlosky, A. Graesser (Eds.), *Metacognition in educational theory and practice* (pp. 277–304). Hillsdale, NJ: Erlbaum.

Zimmerman, B. J. (1990). Self-regulated learning and academic achievement: An overview. *Educational Psychologist*, *25*(1), 3–17.

Zoethout, H., Wesselink, R., Runhaar, P., & Mulder, M. (2017). Using transactivity to understand emergence of team learning. *Small group research*, *48*(2), 190-214.

Appendix

Appendix A Ethics Certification

University of Victoria

Human Research Ethics Board
Office of Research Services
Administrative Services Building
PO Box 1700 STN CSC
Victoria British Columbia V8W 2Y2 Canada
Tel 250-472-4545, Fax 250-721-8960
Email ethics@uvic.ca Web www.research.uvic.ca

Certificate of Renewed Approval with Modifications

PRINCIPAL INVESTIGATOR:	**Allyson Hadwin**	**ETHICS PROTOCOL NUMBER** BCEHI (BoR) -Delegated	**BC18-275**
UVic STATUS:	**Faculty**	ORIGINAL APPROVAL DATE:	13-Sep-18
UVic DEPARTMENT:	**EPLS**	RENEWED ON:	27-Aug-20
		APPROVAL EXPIRY DATE:	12-Sep-21

PROJECT TITLE: **Examining Student Success: Promoting Adaptive Regulation with Innovative Technologies (PAR-IT)**

RESEARCH TEAM MEMBERS: Collaborators: Dr. Phil Winne (SFU), Dr Todd Milford (UVic); Researchers (UVic): Meg Kapil, Ramin Rstampour, Annie Wu, Sarah Davis, Mariel Miller, Hager Yousef, Sarah Greco, Leslie Bahena Olivares, Jiexing Hu;

DECLARED PROJECT FUNDING: **1. SSHRC Insight Grant; 2. Open Educational Resource Grant; 3. Course Redesign Grant**

CONDITIONS OF APPROVAL

This Certificate of Approval is valid for the above term provided there is no change in the protocol.

Modifications
To make any changes to the approved research procedures in your study, please submit a "Request for Modification" form. You must receive ethics approval before proceeding with your modified protocol.

Renewals
Your ethics approval must be current for the period during which you are recruiting participants or collecting data. To renew your protocol, please submit a "Request for Renewal" form before the expiry date on your certificate. You will be sent an emailed reminder prompting you to renew your protocol about six weeks before your expiry date.

Project Closures
When you have completed all data collection activities and will have no further contact with participants, please notify the Human Research Ethics Board by submitting a "Notice of Project Completion" form.

Certification

This certifies that the UVic Human Research Ethics Board has examined this research protocol and concluded that, in all respects, the proposed research meets the appropriate standards of ethics as outlined by the University of Victoria Research Regulations Involving Human Participants.

Dr. Rachael Scarth
Acting Associate Vice-President, Research

BC18-275 Hadwin, Allyson

Certificate Issued On: 27-Aug-20

Appendix B Consent Withdrawal Form (ED-D 101)

Fall 2014

University of Victoria	Consent Withdrawal Form	
Department of Educational Psychology & Leadership Studies		Technology Integration and Evaluation Research Lab

Why participate in research that evaluates student learning and the ED-D 101 Course?

In ED-D 101, you have the opportunity to experiment with your own learning in order to become a better learner. The information and practices that guide you through this process have been developed from theory and research about student learning. Each semester, ED-D 101 undergoes changes and revisions based on findings from the ED-D 101 research. Learning experiences from a large number of students are needed to continue to improve the course. By participating in this research, you inform students, researchers, university instructors, and administrators who strive to help students succeed at university.

Purpose of the research

- To understand how to support students (like yourself) to become academically successful and develop lifelong learning skills.
- To compare learning processes and successes of ED-D 101 students with students who have not taken the course.
- To inform evidence-based decision making about ED-D 101 (expansion, course content, course activities).
- To inform theory and research about strategic regulation in educational psychology and educational technology.

Participation in this research involves

- No additional work or time. Your regular coursework will be examined for research purposes after the course is completed and final grades have been submitted. Data include:
    - ED-D 101 course assignments, lab activities, tests, and discussions (online or audio/video recorded) submitted to CourseSpaces and Fluidsurvey;
    - ED-D 101 CourseSpaces data, including activity reports;
    - Course and assignment grades for concurrent Pathways course; and
    - Institutionally collected performance indicators (e.g. GPA, yearly GPA, and exit surveys) throughout your undergraduate degree
- There are no known or anticipated risks.

Participation is voluntary: You can withdraw at anytime

You may withdraw anytime this semester by clicking on the electronic consent form in CourseSpaces and entering your name and the date. In the case of group work, withdrawal of participation will mean that an individual's contributions to the group will not be examined. When individuals cannot be removed completely from the data sets (e.g., group project grade or shared planning forms), data will be used in summarized form with no identifying information.

Data will be confidential even though coursework is not anonymous

Course assignments and activities with your name or student ID are not anonymous. However, your confidentiality will be protected by (1) summarizing data in a spreadsheet with a random case number whenever possible and (2) summarizing data across many students or using pseudonyms when specific examples are used.

Course instructors will not know you are participating in this research
Instructors and teaching assistants will not know who has consented to participate in the research during the semester. Consent forms will be collected by a third party and released to the research team after course completion and grade submission.

What will happen to data and how will findings be reported and shared?
Electronic data will be archived and stored on a password protected server only accessible to the researchers. Files will be stored for approximately 10 years, after which they will be erased. Data will be analyzed by Dr. Hadwin and her research collaborators. Findings will be presented through academic publications/presentations, the research website (http://allysonhadwin.wordpress.com/), student theses, and reports to university administrators. Identifying information will be removed whenever examples are used in ED-D 101 or presentations.

Social Networking Privacy Notice
Some activities/assignments in this course use social networking platforms such as Google + or ZohoChat. Please be advised that data collected within these platforms are likely stored on servers located outside of Canada. As a result, retention, access to, and the secondary use and disclosure of any personal information you disclose are subject to the social networking site's terms of use, privacy policies and foreign law. You are encouraged you to read the social networking site's terms and conditions on their website prior to starting any activities. Students are encouraged to use first name and last initial only when using these networking tools.

UVic cannot require students to disclose personal information to technologies or organizations which may store information on servers located outside of Canada because disclosure of personal information to vendors, systems or services storing or accessing that personal information outside of Canada is restricted by Section 30.1 of BC's Freedom of Information and Protection of Privacy Act (FIPPA). Personal information is information about an identifiable individual; for example, your name or your email address. If you are not comfortable with your personal information being stored outside of Canada, you may sign up for the tool using a nickname and non-identifying email. However, you will be required to inform your instructor of the nickname and email you choose.

Contacts
Feel free to contact any of the following with questions, comments, or concerns:

- During the course: Dr. Tim Black (eplschr@uvic.ca) or Dr. Ralf St. Clair (deaneduc@uvic.ca)
- After the course: Dr. Allyson Hadwin (hadwin@uvic.ca) [Note: Do not contact Dr. Hadwin during the course because she is a course instructor and cannot know which students are participating until course grades are submitted.]
- Human Research Ethics Office at the University of Victoria (250-472-4545 or ethics@uvic.ca). This research (Par21: Promoting Adaptive Regulation for the 21st Century) is led by Dr. Allyson Hadwin (Principal Investigator) and funded by the Social Sciences and Humanities Research Council of Canada (SSHRC-INE grant) and the Canadian Foundation for Innovation (CFI-LOF).

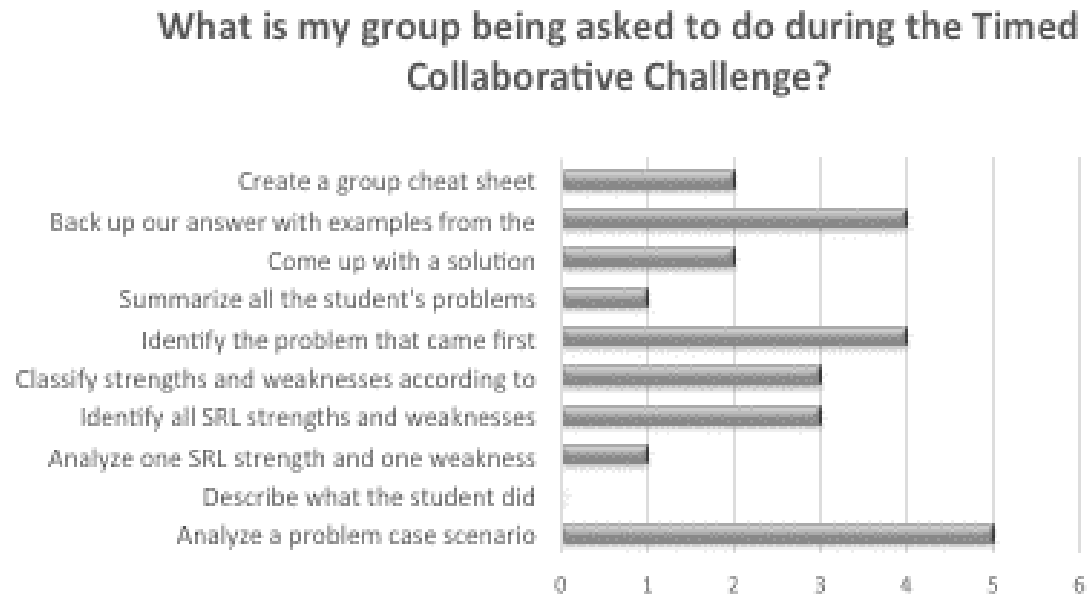
By registering in ED-D 101, you are automatically included in research about student learning and success. Entering your name and the date below indicates you would like to withdraw your consent from research in ED-D 101.

Name:

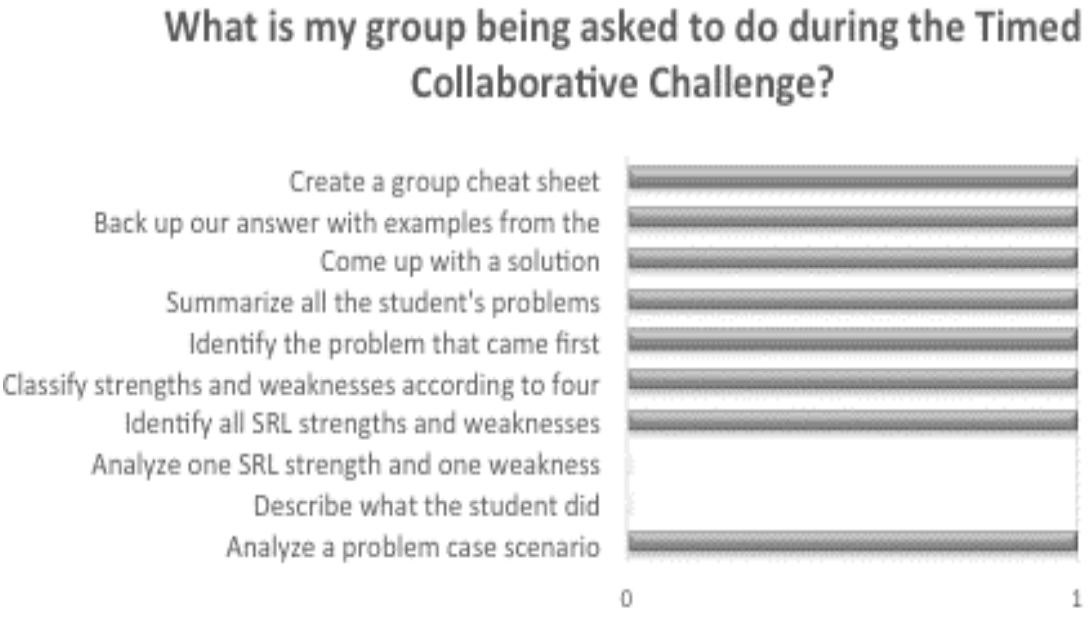
Date:

Appendix C Planning support conditions

Example of Quantified Visualization

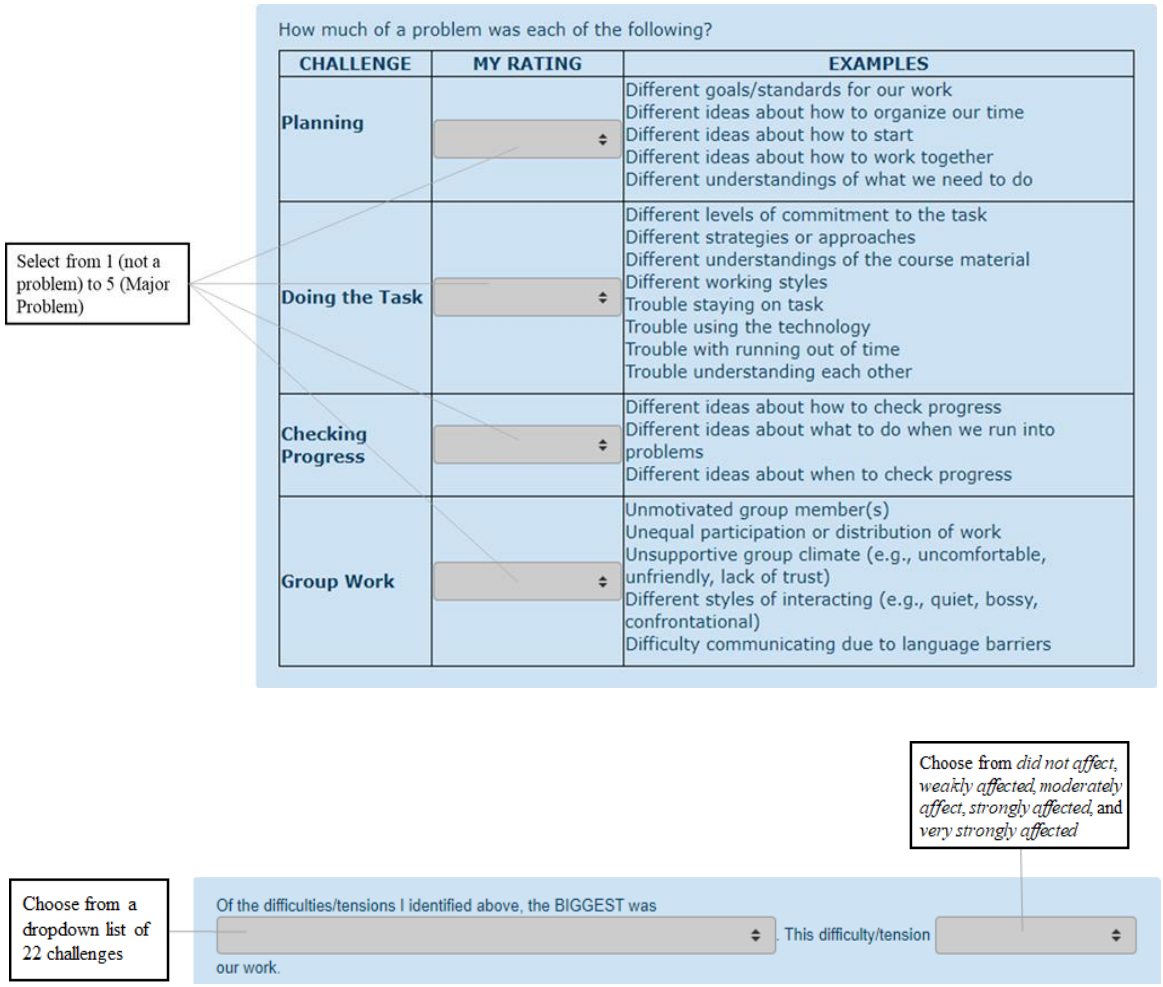


Example of Nominal Visualization



Appendix D Individual Reflection Activity

Individual Reflection Tool



Appendix E Challenge Categories and Specific Items

Challenge Categories	Specific Challenge Items
Planning	Constructing or aligning accurate perceptions of the task, identifying goals and priorities, planning strategies or approaches
	Different goals/standards for our work
	Different ideas about how to organize our time
	Different ideas about how to start
	Different ideas about how to work together
	Different understandings of what we need to do
Doing the task	Actions, states, or knowledge contributing to task processes & products
	Different levels of commitment to the task
	Different strategies or approaches
	Different understandings of the course material
	Different working styles
	Trouble staying on task
	Trouble using the technology
	Trouble understanding each other
	Running out of time
Checking progress	Checking process or progress against goals/standards and making adjustments as necessary
	Different ideas about how to check progress
	Different ideas about what to do when we run into problems
	Different ideas about when to check progress
Group Work	Socioemotional interaction and communication
	Unmotivated group member(s)
	Unequal participation or distribution of work
	Unsupportive group climate (e.g., uncomfortable, unfriendly, lack of trust)
	Different styles of interacting (e.g., quiet, bossy, confrontational)
	Difficulty communicating due to language barriers