Regulating Emotions in Computer-Supported Collaborative Problem-Solving Tasks

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M.A., University of Victoria, 2010
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Abstract

The ability to collaborate has been identified as an essential learning outcome for the 21st century. However, if group members lack the skills, abilities, and attitudes to work in a team, these groups may work inefficiently or fail to achieve what they set out to do. To achieve success, group members need to engage in productive regulatory processes to manage cognitions, behaviors, motivation, and emotions as needed to attain desired outcomes. One area of regulation that has been underemphasized in collaborative contexts is the regulation of emotions. Therefore, the purpose of this multi-paper dissertation was to examine the emotional experiences of undergraduate students working collaboratively on two online time-limited problem-solving tasks. Using a regulation of learning framework, the research unfolded over four studies drawing from a variety of data sources and building upon one another to explore the socio-emotional aspect of online collaboration. Study 1 (Webster & Hadwin, 2018) provides an overview of students' emotions and plans for emotion regulation, self-reported during two collaborative tasks, offering an in-the-moment picture of how students feel and how they respond to those feelings. Study 2 (Bakhtiar, Webster, & Hadwin, 2018) consisted of a comparative case study to examine differences in regulation and socio-emotional interactions between two groups with contrasting socio-emotional climates. Findings revealed differences between these groups in terms of planning and preparation; therefore, the final two studies examined emotions and emotion regulation strategies reported during groupwork under different levels of planning and preparation at the individual or group level. Study 3 (Webster & Hadwin, 2019) documented the types of strategies students recalled using individually and as a group to regulate a salient emotion during collaboration and compared strategies between groups who were given different types of collaborative planning support. Finally, Study 4 (Webster, Davis, & Hadwin, 2019)

compared emotions, emotion regulation strategies, and evaluations of strategy effectiveness for a purposeful sample of students who were well-prepared versus underprepared for the first of two collaborative working sessions. Four overarching factors emerged from this research as important for productive emotion regulation in online collaboration: (a) planning and preparation, (b) regulating both negative and positive emotions, (c) regulating at both individual and group levels, and (d) providing support for selecting and enacting helpful strategies. With further research, tools and interventions can be improved and utilized to support students to productively regulate in collaborative groups.

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1. Webster, E. A.[a], & Hadwin, A. F. (2018). *Exploring emotions and plans for emotion regulation during computer-supported collaborative problem solving.* Manuscript in preparation.

2. Bakhtiar, A., Webster, E. A.[b], & Hadwin, A. F. (2018). Regulation and socio-emotional interactions in a positive and a negative group climate. *Metacognition and Learning, 13*(1), 57–90. https://doi.org/10.1007/s11409-017-9178-x

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

4. Webster, E. A.[a], Davis, S. K., & Hadwin, A. F. (2019). *Planning and emotion regulation during two online collaborative tasks.* Manuscript in preparation.

[a]Primarily responsible for study design, data analysis, interpretations, and writing.
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Introduction

The ability to collaborate has been identified as an essential learning outcome for the 21st century (Partnership for 21st Century Skills, 2011). When done effectively, collaboration can result in outcomes that are better than what individual group members could achieve alone (Barron, 2003; Van den Bossche, Gijselaers, Segers, & Kirschner, 2006; W. M. Williams & Sternberg, 1988). It is not surprising, therefore, that teamwork is becoming more popular in the workplace, and the ability to work well on a team is a sought-after skill (Chen, Donahue, & Klimoski, 2004). Furthermore, with a growing emphasis on virtual teamwork in the workplace (Martins, Gilson, & Maynard, 2004), the ability to collaborate not just face-to-face, but in online environments, is an important skill for university students to attain.

Productive collaboration is not easy, and simply putting together a group of knowledgeable individuals does not guarantee success (Barron, 2003). If group members lack the skills, abilities, and attitudes to work in a team, these groups may—at best—work inefficiently or—at worst—fail to achieve what they set out to do, with unhappy and dissatisfied group members as a result (Chen et al., 2004; Stevens & Campion, 1994; Van den Bossche et al., 2006). To achieve success, group members need to engage in productive regulatory processes to manage cognitions, behaviors, motivation, and emotions as needed to attain desired outcomes (Hadwin, Järvelä, & Miller, 2018; Järvelä & Hadwin, 2013). Thus, research examining regulation of learning in collaborative contexts is important for understanding how effective collaboration can be supported in groups.

One area of regulation that has been underemphasized in collaborative contexts is the regulation of emotions (Järvenoja & Järvelä, 2009; Volet & Mansfield, 2006). Group work can present a multitude of social, cognitive, and practical challenges that "place significant emotional

pressure on individuals to restore their wellbeing, maintain motivation, and achieve personal and group oriented goals" (Järvelä, Volet, & Järvenoja, 2010, p. 16). Students assigned to work in groups may experience emotions connected to themselves, to the task itself, to the task context or environment, or to one or more other group members (Järvenoja & Järvelä, 2005; Wosnitza & Volet, 2005). Regardless of the source, these emotions may facilitate or hinder the process and, ultimately, the outcomes of group work. Indeed, research indicates that affect plays an important role in group work, with positive affect typically associated with beneficial effects and negative affect, if strong and persistent, typically associated with detrimental effects (Jehn, 1997; Rogat & Linnenbrink-Garcia, 2011; Volet, Summers, & Thurman, 2009). Accordingly, the ability to regulate helpful or harmful emotions in a group setting is one factor that may contribute to effective collaboration.

The study of emotions and emotion regulation in group work is beginning to emerge (e.g., Ayoko, Konrad, & Boyle, 2012; Järvenoja & Järvelä, 2009; Näykki, Järvelä, Kirschner, & Järvenoja, 2014), but there remains a need for further research in this area, particularly in the context of computer-supported collaborative learning (CSCL; Dillenbourg, Järvelä, & Fischer, 2009; Järvelä et al., 2015). Not only might CSCL environments present different emotion-eliciting challenges than face-to-face environments, but the expression and regulation of emotions might also differ, particularly when group members are limited to chat-based communication where traditional non-verbal cues, such as facial expressions and body language, are absent. Examining the emotions students experience and how they regulate those emotions during online collaborative work will therefore contribute to a relatively understudied area of research in regulation and CSCL.

The purpose of this multi-paper dissertation was to examine the emotional experiences of undergraduate students working collaboratively on two online time-limited problem-solving tasks, from a regulation of learning perspective. The dissertation research unfolded over four studies drawing from a variety of data sources and building upon one another to explore the socio-emotional aspect of online collaboration. Employing a quantitative descriptive research design, Study 1 (Webster & Hadwin, 2018) provides an overview of students' emotions and plans for emotion regulation, self-reported during two collaborative tasks, offering an in-the-moment picture of how students feel and how they respond to those feelings.

In Study 2 (Bakhtiar, Webster, & Hadwin, 2018), we conducted a comparative case study to examine differences in regulation and socio-emotional interactions between two groups with contrasting socio-emotional climates. We examined multiple sources of data in the first collaborative task, allowing us to generate four themes to describe key differences between one group with a positive socio-emotional climate and one group with a negative socio-emotional climate. Findings revealed differences between these groups in terms of planning and preparation; therefore, the final two studies examined emotions and emotion regulation strategies reported during groupwork when different levels of planning support were provided to individuals and groups.

Study 3 (Webster & Hadwin, 2019) focused on students' reflections about their collaborative experiences. This quasi-experimental study documented the types of strategies students recalled using individually and as a group to regulate a salient emotion during collaboration and compared strategies between groups who were given different types of collaborative planning support. Finally, Study 4 (Webster, Davis, & Hadwin, 2019) was a process-based analysis of emotion regulation that built on the previous studies by comparing

emotions and plans for emotion regulation reported during the task as well as reflections and evaluations about emotion regulation strategies reported after the task for a purposeful sample of students who were well-prepared versus underprepared for the first of two collaborative working sessions.

Together, these studies contribute to a richly detailed, multi-faceted perspective of the emotions students experience and how they regulate those emotions in the context of collaborative work. Findings from this research contribute to the growing literature in the area of emotion regulation in collaboration informing future research and interventions designed to facilitate effective collaboration. Furthermore, this research contributes to the theoretical development of socially-shared regulation of learning by addressing the role of emotions and their regulation as part of a regulation of learning framework in collaborative contexts.

Theoretical Framework: Regulating Learning in Collaboration

Hadwin and Järvelä (Hadwin, Järvelä, et al., 2018; Järvelä & Hadwin, 2013) posit that successful collaboration involves three different modes of regulation: self-regulated learning (SRL), socially-shared regulation of learning (SSRL), and co-regulated learning (CoRL). SRL refers to goal-directed, strategic, and metacognitive engagement in learning; it involves monitoring, evaluating, and adapting cognitions, behaviors, and motivation/affect to accomplish personal goals (Pintrich, 2000; Zimmerman, 1989, 1990). In the context of collaboration, SRL refers to individual group members regulating their own learning in the interest of the group task; SSRL refers to group members regulating together towards shared outcomes; and CoRL refers to coordinating, prompting, or constraining self-regulation of other group members and/or shared regulation of the group (Hadwin, Järvelä, et al., 2018).

Winne and Hadwin's (1998, 2008) model of SRL provides a good framework for examining self-, co-, and shared regulatory processes and constructs. Their model describes learning as a weakly sequenced, recursive process of (a) developing task perceptions, (b) creating task-specific goals and plans, (c) strategically selecting and enacting tactics to achieve goals, and (d) adapting as needed within and across tasks on the basis of metacognitive monitoring and evaluating. Five features underlie each phase of the cycle, denoted by the acronym COPES: conditions, operations, products, evaluations, and standards. Internal and external *conditions* provide a context for engagement in each phase. Internal conditions are comprised of factors internal to the student (or group), such as prior knowledge, motivation, and emotions; external conditions are comprised of factors external to the student (or group), such as task demands, resources available, and the social context. Students cognitively process or manipulate information through *operations*, resulting in *products* in each phase, which may in

turn become conditions for the next phase. Finally, students make *evaluations* of the products by comparing them to *standards*. In collaborative contexts, this model provides a useful framework for research because (a) it highlights task understanding as a separate—and foundational—phase of planning and (b) it describes the underlying mechanisms that propel the cycle. These aspects of the model allow for a nuanced approach to examining the unfolding of regulation at both individual and group levels as well as the interaction between levels of regulation.

Hadwin, Järvelä, et al. (2018) describe how the four regulatory phases and underlying COPES architecture can be extended to represent how individual group members and groups productively regulate their learning when working on a task together. Individual group members develop their own task perceptions, create their own goals and plans, strategically select tactics for completing the task, and metacognitively monitor and evaluate their own progress, which may prompt changes to their engagement within and across collaborative tasks. Similarly, groups develop shared task perceptions, create shared goals and plans, coordinate strategy enactment, and collectively monitor and evaluate progress to inform next steps within and across tasks. As groups move through a task, these individual and shared regulatory processes can occur simultaneously and dynamically interact.

To elaborate, each group member carries their own set of conditions (e.g., task perceptions, goals, emotions) that influence subsequent regulatory actions and are updated as they move through the phases. Groups also carry a set of conditions (e.g., shared task perceptions, shared goals, group emotional state) that are updated as they move through the phases. Importantly, individual and group conditions are not isolated, but rather influence each other and alter the foundation upon which subsequent learning occurs. For example, one member's strong feeling of anxiety may negatively impact the group's emotional state. In

response, another group member may co-regulate their groupmate's anxiety by suggesting they take some deep breaths. The group may also collectively enact strategies to improve the group's emotional state, such as by sharing positive statements about their progress to encourage each other and reduce feelings of anxiety.

Although Winne and Hadwin's (1998) model initially emphasized cognitive information processing, it also acknowledged motivational factors and social context as part of the conditions for engaging in studying (Greene & Azevedo, 2007; Puustinen & Pulkkinen, 2001). In 2008, Winne and Hadwin more explicitly outlined the role of motivation and emotions in the model, highlighting that emotions are both conditions and products of regulatory activities. Furthermore, when learners evaluate their emotional products against affective standards and perceive a discrepancy, this can initiate regulatory action to change their emotional state. In the following sections, I first define emotions and then elaborate on the role of emotions as (a) both internal conditions and products of the phases and (b) targets of regulatory processes.

Academic Emotions

Emotions can be viewed as multi-componential entities made up of cognitive processes, affective experiences or feelings, physiological responses, expressions, and action tendencies (Kleinginna & Kleinginna, 1981; Scherer, 2005; Solomon, 2008). Rosenberg (1998) differentiates emotion from mood, such that emotions are considered to be relatively brief affective states that occur in response to specific events or objects, whereas moods are longer-lasting states that do not necessarily have identifiable triggers. With respect to this distinction, this dissertation primarily focuses on emotions. However, there is likely overlap between emotions and moods, with some researchers treating these constructs more or less interchangeably (e.g., Koole, 2009; Lucas et al., 2009; Pekrun, 2006).

In academic settings, emotions can be classified into different types (Harley, Lajoie, Frasson, & Hall, 2017; Pekrun & Linnenbrink-Garcia, 2012), including achievement emotions (e.g., Pekrun, 2006), epistemic emotions (e.g., Muis, Chevrier, & Singh, 2018), topic emotions (e.g., Broughton, Sinatra, & Nussbaum, 2013), and social emotions (e.g., Hareli & Weiner, 2002; Weiner, 2007). In a collaborative context, for example, emotions can arise from (a) the group activity or outcomes of the activity, such as feeling hopeful or optimistic the group will produce a successful product (achievement emotions); (b) cognitive processing of information, such as confusion when a group member contributes information that conflicts with existing ideas (epistemic emotions); (c) responses to task content, such as interest (topic emotions); and (d) interactions with other group members, such as feeling angry that a group member did not complete their part of the project (social emotions). Emotions may also result from environment and task conditions (e.g., frustration with malfunctioning technology, anxiety about time constraints, etc.) as well as other unrelated factors (e.g., not getting enough sleep, relationship conflicts, etc.). Given that a variety of emotions can occur in a collaborative context and there is likely overlap among the different types of emotions (Harley et al., 2017), I did not focus on a specific type of emotions in this research, but rather examined emotions that may be relevant for the particular collaborative context in which this research took place.

In Pekrun's (2006) control-value theory of achievement emotions, discrete emotions are categorized along two dimensions that are commonly viewed as important: valence (positive vs. negative) and activation (activating vs. deactivating; Barrett & Russell, 1998). The theory predicts differential outcomes depending on an emotion's valence and activation. For example, positive activating emotions (e.g., enjoyment) may increase motivation whereas negative deactivating emotions (e.g., boredom) may decrease motivation (Pekrun, Goetz, Titz, & Perry,

2002). However, in our past research with students recalling emotions while studying independently, a scale reliability analysis indicated emotions fit better together when grouped solely by valence rather than by both dimensions (Webster & Hadwin, 2015). In addition, we found boredom was a unique emotion that did not fit on the other scales and, thus, analyzed it independently. From a regulation of learning perspective, the properties of an emotion (i.e., type, valence, and activation) are less relevant than how and why students perceive and respond to that emotion. For these reasons, it is important to reiterate that this dissertation research focused less on analyzing different discrete emotions and more on exploring patterns of emotional responses and regulation.

Emotions as Conditions and Products of Regulation

In the COPES framework, emotions, along with a number of motivational beliefs, are conceptualized as both conditions and products in regulation (Winne & Hadwin, 2008). Extending this to collaborative teamwork, an emotion such as anxiety can function as a condition constraining one group member from disagreeing with another group member while answering a question on a collaborative assignment. When other group members agree and move onto the next question, this might result in the original member feeling disappointment (a product) for not speaking up. This negative feeling may then become a condition interfering with that member's ability to focus on the next question.

Although the distinction between emotions as conditions or products is not always apparent, theory and research indicate emotions play an important role in group work through connections with other important group constructs, such as social-behavioral engagement (Duffy & Shaw, 2000; Linnenbrink-Garcia, Rogat, & Koskey, 2011), conflict management (Ayoko, Callan, & Hartel, 2008; Jehn, 1997), and trust and cohesion (Dunn & Schweitzer, 2005;

Jarvenpaa, Knoll, & Leidner, 1998; Jones & George, 1998; Lawler, 2001; Lawler & Thye, 1999; Lawler, Thye, & Yoon, 2000; Porter & Lilly, 1996; Wegerif, 1998; M. Williams, 2007). For example, in two studies of small groups of elementary school students working on math activities, Linnenbrink-Garcia et al. (2011) found that (a) higher levels of negative affect were associated with social loafing and (b) higher levels of positive affect were associated with positive group interactions. Furthermore, qualitative and quantitative analyses across three math activities in the second study suggested that social-behavioral engagement and affect were reciprocally linked. Building from Winne and Hadwin's (1998, 2008) model, affect can be conceptualized as a product and a condition of these small-group interactions, which we posit are outward instantiations of cognitive operations (Study 2; Bakhtiar, Webster, & Hadwin, 2018). Because students reported their affect only after each activity was finished, attaining self-reports immediately before and during a group activity might provide additional insight into the role of emotions as group work unfolds.

In the context of collaboration, it is important to consider not just individual emotions, but group emotions as well. At any given point during a collaborative task, individual group members can experience similar or different emotions, resulting in varying group emotional states throughout the task. Similar to individual emotions, a group's emotional state can be considered both a condition that has the potential to influence subsequent activity and a product that results from past or current activity. In organizational research, the construct of group affective tone, which refers to a homogeneous affective state within a group (George, 1990), has been linked to a variety of group processes and outcomes, such as cooperativeness, perceptions of task performance, and conflict (Barsade, 2002); dysfunctional behavior and supervisor-rated work performance (Cole, Walter, & Bruch, 2008); and social loafing, potency (belief in the

effectiveness of one's group), and group performance (Duffy & Shaw, 2000). In educational research on collaborative learning and regulation, findings from a limited number of studies indicate that establishing and maintaining a positive emotional atmosphere in the group might be a contributing factor to more effective collaboration (e.g., Järvenoja & Järvelä, 2013; Linnenbrink-Garcia et al., 2011; Volet et al., 2009). For example, Volet et al.'s (2009) qualitative analysis suggested that shared positive emotions related to the task may have helped to prolong an episode of what they considered high-level co-regulation in a face-to-face group of six university students. As indicated by the authors, there is a need for further research into the role of the factors, including shared positive emotions, that contribute to high-level co-regulation.

Emotions as Targets of Regulation

In addition to being conditions and products, emotions can also become targets for regulation when students evaluate emotional products against standards and perceive a discrepancy (Winne & Hadwin, 2008). The criteria used to make evaluations can be influenced by a variety of factors, such as task goals and other internal or external conditions framing the regulatory process. For example, consider two students experiencing a similar level of anxiety. One student might perceive this anxiety as good because it will increase his or her focus on the task, whereas the other student might perceive this anxiety as bad because he or she places more importance on feeling good. In other words, these two students have appraised the situation differently on the basis of their goals (Boekaerts, 2011; Boekaerts & Niemivirta, 2000). In terms of regulating that anxiety, the first student may intentionally maintain it (e.g., by thinking about the importance of the task), whereas the second student may intentionally decrease it (e.g., by focusing on something less anxiety-provoking). Thus, students' perceptions of their emotions—rather than the emotion itself—prompt regulatory action. As the cycle continues, regulating

students will also metacognitively monitor and evaluate the effectiveness of their strategies, using this information to make decisions about next steps.

From the perspective of Winne and Hadwin's (1998, 2008) model, regulating emotions involves (a) being aware of and understanding emotions and their impact, (b) setting goals and devising plans for influencing the type, timing, and/or intensity of emotions (Gross, 1998, 1999; Koole, 2009; Thompson, 1994), (c) enacting tactics and strategies for achieving goals, and (d) adapting the approach to regulating emotions when the need arises. In collaborative learning contexts, these processes should occur at both the individual and group level (Järvenoja & Järvelä, 2009). That is, successful regulation of emotions in collaboration may require (a) individuals regulating their own emotional states (SRL), (b) group members prompting fellow group members to regulate their emotional states (CoRL), and (c) groups regulating their emotional states together (SSRL; Hadwin, Järvelä, et al., 2018).

To date, few published studies have examined emotion regulation in collaborative learning contexts, although research in this area is growing (Ayoko et al., 2012; Järvenoja & Järvelä, 2005, 2009; Järvenoja, Järvelä, & Malmberg, 2017; Lajoie et al., 2015; Näykki et al., 2014; Rogat & Adams-Wiggins, 2015; Rogat & Linnenbrink-Garcia, 2011; Xu, Du, & Fan, 2013, 2014). For example, Järvenoja and Järvelä (2009) investigated emotion regulation in face-to-face groups of three to five Finnish teacher education students. After completing each of three collaborative tasks, students filled out the Adaptive Instrument for Regulation of Emotions (AIRE; Järvenoja, Volet, & Järvelä, 2013), which assessed their goals for the task, the socio-emotional challenges they experienced, and how they regulated in response to their main socio-emotional challenge. Findings revealed that students reported mainly individual and shared regulation, with fewer instances of co-regulation, providing evidence that students perceive the

occurrence of socially-shared regulation in face-to-face collaborative contexts. Järvenoja et al. (2017) examined the use of a mobile application tool to support emotion and motivation regulation during face-to-face collaborative learning and found that (a) more often than not, at least one or more group members indicated a challenging emotional state when prompted to individually report their emotional state at the beginning of each group session, (b) co-regulation of emotions occurred more often than shared regulation of emotions, but shared regulation was longer in duration, and (c) emotional states were correlated with co-regulation, but not shared regulation, and only at the beginning of the session. The authors did not examine the specific strategies employed by individuals or groups to regulate emotions and called for further research into shared strategies compared to self-regulated strategies.

A limited number of studies have focused on the specific strategies students and groups use to regulate emotions. For example, Näykki et al. (2014) analyzed video data of six university students collaborating on a task who encountered more socio-emotional challenges than other groups. Coding of the video data revealed that group members engaged mainly avoidance- and problem-focused emotion regulation strategies, such as withdrawal and attempts to re-engage in the group, in response to socio-emotional challenges. This study provided valuable information about regulation that occurred in a poorly functioning group, but to more fully appreciate productive vs. unproductive forms of regulation, analysis of a well-functioning group is necessary, as the authors note.

A qualitative study by Ayoko et al. (2012) examined online groups of four to six university students finding that emotion regulation occurred in online groups as well. Ayoko et al. (2012) observed group members apologizing or explaining their intent after making a negative statement as well as third-party group members jumping in to mediate in the threat of

conflict. These actions appeared to help resolve conflict and reduce communication of negative emotion. In addition, in some cases, it appeared that communicating negative emotions with the group was beneficial in helping group members to identify and resolve problems with their understanding and goals for the project. Towards the end, communicating positive emotions appeared to help motivate groups to carry on until the task was complete. Findings from these studies are useful in providing information about how students overtly regulate their emotions during face-to-face or online collaboration. However, because these studies have mainly relied on observational data, unobservable strategies such as taking deep breaths or positive self-talk may be underrepresented. Further research about both individual- and group-level emotion regulation strategies is needed, particularly in online collaborative learning contexts.

Frameworks exist for classifying strategies from an individual perspective (e.g., Gross, 1998; Koole, 2009; Schutz, Distefano, Benson, & Davis, 2004) and can be used to develop an inventory of strategies for online collaboration. For example, Gross's (Gross, 1998, 2008) commonly-used process model includes five categories of strategies that are initiated at different points in the emotion-generating situation: situation selection (i.e., approaching or avoiding particular people or environments), situation modification (i.e., altering the environment), attentional deployment (i.e., redirecting or withdrawing attention), cognitive change (i.e., altering appraisals of a situation), and response modulation (i.e., changing the physiological, experiential, or behavioral emotional response). The first four categories represent antecedent-focused strategies that occur before an elevated emotional response, whereas the last category represents response-focused strategies that occur once an emotion has fully developed. In the context of test taking, Schutz et al. (2004) distinguished among three categories of strategies: task-focusing processes (e.g., "I work harder to find the main idea in the questions"); regaining task-focus

processes, including tension reduction (e.g., “I try to slow down my breathing”) and importance reappraisal (e.g., “I tell myself that high test scores are not very important”); and emotion-focusing processes, including wishful thinking (e.g., “I find myself wishing the test was over”) and self-blame (e.g., “I blame myself for the problems I am having on the test”). Finally, Koole (2009) summarized the different approaches to emotion regulation into a target by function classification, with target referring to the emotion-generating system that is the focus of regulation (i.e., attention, knowledge, or body) and function referring to the outcomes sought through regulation (i.e., to satisfy hedonic needs, to achieve goals, or to optimize personality functioning). For instance, cognitive reappraisal (Gross, 1998) is considered a goal-oriented strategy targeting knowledge (i.e., cognitions related to the emotional event), whereas suppressing an expressive response (Gross, 1998) is considered a goal-oriented strategy targeting the body. Using these frameworks along with the existing research examining emotion regulation in collaborative contexts is important for building an inventory of strategies that students and groups may use and experiment with during collaboration.

Summary

This dissertation research draws on Winne and Hadwin’s (1998, 2008) model of SRL to examine emotions and their regulation in online collaborative learning. When extended to a collaborative context, the model highlights how emotions serve as individual and group conditions setting the stage for engagement in self-, co-, and socially-shared regulatory activities (Hadwin, Järvelä, et al., 2018). The products of these regulatory activities include updated emotions, which become conditions for the next phase of regulation. Emotions can also become a target of regulation when individuals and/or groups recognize a need for intentionally altering or maintaining their current emotional state. Given the multifaceted role and dynamic nature of

emotions in regulated learning, the next chapter turns to methodological considerations for investigating emotions from a regulation of learning perspective.

Methodological Considerations: Researching Emotions and Emotion Regulation From a Regulation of Learning Perspective

This chapter outlines how a regulation of learning perspective informed the methodological choices I made in conducting this dissertation research, with a particular focus on the design of two primary data collection tools: the Socio-Emotional Sampling Tool (SEST; Webster & Hadwin, 2012b, 2014) and the Socio-Emotional Reflection Tool (SERT; Webster & Hadwin, 2012a). Four overarching factors were considered.

First, as conditions and products of regulation (Winne & Hadwin, 2008), it is important to examine emotions and their regulation as situated and dynamic processes that interact with other contextual variables, such as the social aspects inherent in collaborative learning.

Second, because regulation is assumed to be goal-directed and adaptive (e.g., Pintrich, 2000; Winne & Hadwin, 1998, 2008) (a) the goals of the learner (or group) should be taken into account when interpreting regulatory actions, and (b) capturing change over time is vital for detecting small- and large-scale adaptation.

Third, adopting the view that challenges invite regulatory actions (e.g., Hadwin, Järvelä, et al., 2018) emphasizes the importance of research that focuses on emotion regulation in the context of emotionally challenging situations occurring during collaboration. Furthermore, I argue that understanding what learners (and groups) do to maintain or increase desirable emotional states may provide insight into regulatory actions that can prevent or reduce future challenges.

Fourth, given the importance of metacognitive monitoring in propelling regulation (e.g., Hadwin, Järvelä, et al., 2018; Winne & Hadwin, 1998) tools and supports for emotion regulation should serve to enhance students' awareness of their current and past emotional processes. This means the tools used in real-life collaborative contexts should not only provide data for research

analysis, but should also provide data that are useful for students in planning and reflecting on their own regulatory experiences (Winne, 2018). These four factors are elaborated upon in the following sections.

Emotional Processes are Situated and Dynamic

Emotions are often viewed as dynamic and context-specific, meaning they can fluctuate and change over time and context, resulting from transactions between person and environment (Efklides & Volet, 2005; Schutz, Hong, Cross, & Osbon, 2006). In educational settings, emotions have been conceptualized as socially constructed and closely entwined with cognitive and motivational aspects of learning (e.g., Op 't Eynde & Turner, 2006; Schutz et al., 2006). This means that capturing information about individuals' emotions and how they regulate those emotions is not an easy task. Proponents of design-based research (e.g., Barab & Squire, 2004; Brown, 1992) highlight the complexities involved in conducting research in naturalistic settings, referring specifically to the difficulty with attempting to isolate one variable and control all other variables. The effects of interest are likely a result of multiple variables interacting in complex ways. Indeed, researchers examining emotions in academic contexts emphasize the need for multi-method, multi-level analyses that take into account and integrate corresponding cognitive, motivational, and socio-contextual variables (Järvelä et al., 2010; Meyer & Turner, 2006; Op 't Eynde & Turner, 2006; Schutz & DeCuir, 2002). For example, Op 't Eynde and Turner (2006) suggest interviews, observations, and discourse analysis are more effective methods than questionnaires alone for better understanding students' beliefs, interpretations, and appraisals. Furthermore, taking into account contextual variables, including the learning environment as well as the bigger social-historical context in which students' learning activities occur, will provide a more complete picture of students' emotional experiences (Schutz et al., 2006).

Global Survey Measures Are Inadequate for Capturing Situated Emotional Processes. When researching emotion processes in educational settings, it is therefore important to use methods that capture the dynamic, contextualized nature of emotions; however, many existing measures and approaches commonly used in educational research fail to do this, instead tapping into relatively stable patterns of emotion processes, generalized across events (e.g., Dettmers et al., 2011; Goetz, Frenzel, Pekrun, Hall, & Lüdtke, 2007; MacCann, Fogarty, Zeidner, & Roberts, 2011; Pekrun, Elliot, & Maier, 2009; Ruthig et al., 2008; Srivastava, Tamir, McGonigal, John, & Gross, 2009). For example, to investigate the relation of perceived academic control and academic emotions with achievement in undergraduate students, Ruthig et al. (2008) administered a survey at the beginning of the academic year to groups of first-year undergraduate students. The emotion items on the survey were adapted from the Achievement Emotions Questionnaire (AEQ; Pekrun, Goetz, & Perry, 2005; Pekrun et al., 2002) and contained statements such as "The content is so boring that I often find myself daydreaming" and "I enjoy learning new things." Participants were asked to indicate how true the statements were of them from 1 (*not at all true*) to 5 (*completely true*). Responding to the items in this measure requires participants to reflect across several events to make judgments about how they generally feel. Aside from masking the dynamic nature of emotions, one potential problem with this type of measure is that it is unclear whether students are basing their judgments on one event (e.g., a recent or salient event) or attempting to average across several events. Another consideration is that students' memory for those events could be inaccurate and biased towards recalling how they think they should feel or the most salient emotion they experienced (Kahneman & Riis, 2005; Robinson & Clore, 2002). This is not to say that reflecting on an event is invaluable; indeed, reflecting encourages students to figure out what went well and what did not go well in

order to adapt appropriately in future tasks. However, there is a difference between generalizing across events and reflecting on a specific, recent task that gives students a real, unique experience—rich with personal, social, contextual, and task-specific variables—on which to base their reports.

The Importance of Capturing Emotional Processes in Situ. Järvenoja et al. (2018) emphasize the importance of conducting research in ecologically valid learning contexts. They point out that examining affective processes during authentic collaboration has allowed them "to analyse motivation and emotion regulation in a context that is not isolated but includes all the situational and contextual features that affect the activation of motivation and emotion regulation" (Järvenoja et al., 2018, p. 87). Thus, taking a situated, process-oriented approach to examining emotion regulation is vital for understanding learners' emotional processes as part of the complex picture of regulated learning. This approach has been taken by researchers examining students' emotions directly connected to specific situations and activities during both individual and group learning (e.g., Ainley, Corrigan, & Richardson, 2005; D'Mello & Graesser, 2012; Järvenoja & Järvelä, 2005, 2009; Järvenoja et al., 2017; Linnenbrink-Garcia et al., 2011; Nett, Goetz, & Hall, 2011). For example, to examine the sources of students' emotions during computer-supported learning projects, Järvenoja and Järvelä (2005) interviewed 18 Finnish secondary school students either during or immediately after their lessons, asking not only about students' emotions, but also about their goals, learning strategies, interpretations, and beliefs. In addition, they gathered further data about two students through video recordings and observation of 10 lessons. These methods allowed the researchers to gather rich data about students' emotional experiences and the processes related to those experiences in real-life learning episodes. Using a different approach, Nett et al. (2011) examined students' techniques for coping

with boredom during math class. Students were provided with a personal digital assistant, which signaled randomly during their math class, prompting students to respond to single-item measures assessing (a) the intensity of three emotions (boredom, anxiety, enjoyment) on a scale from 1 (*not at all*) to 5 (*very strongly*), (b) the extent to which they were using four types of coping strategies (e.g., "I am reminding myself that the material is important") on a scale from 1 (*not true at all*) to 5 (*absolutely true*), and (c) their perceptions of how important the outcome of the current activity was to them. They obtained these data on 14 days over five months. These data allowed the researchers to examine frequency of students' boredom experiences and use of different types of coping strategies as well as relations between specific emotions and specific coping strategies. The two studies described here differed in their methods (the former qualitative, the latter quantitative), but both obtained data about students' emotional processes in real-life learning situations.

The Development of Situated Tools for This Dissertation Research. In this dissertation research, using general survey tools would have been inappropriate for assessing the situated, dynamic emotional processes of students in a CSCL context. Instead, the research tools needed to be meaningful to the students, sensitive to the context, and conducive to capturing change. This resulted in creating the Socio-Emotional Sampling Tool (SEST; Webster & Hadwin, 2012b, 2014), which is a relatively brief, unobtrusive tool completed by students immediately before, during, and after a CSCL task (see Appendix A for a copy of the SEST). The SEST prompted students to indicate (a) their current emotion related to working with their group; (b) the source of their emotion; (c) a goal for regulating their emotion (i.e., to increase, decrease, maintain, switch, or do nothing about the emotion); (c) the strategy they intend to use to regulate their emotion; and finally, (d) if the strategy is something for the student to do alone,

for others in the group to do, for each group member to do, or for the group to do together. The narrative response format embeds response choices (either open text field or drop list items) in a series of sentences to form a self statement. Respondents are invited to toggle their choices until they produce a self-narrative statement (often a paragraph) that represents their experience. In this way, responses to each item are contextualized by responses to previous items to form a self-statement meaningful to the student and providing important information about students' emotional experiences and processes during collaboration.

Students were also encouraged to reflect on their emotional experiences via the Socio-Emotional Reflection Tool (SERT; Webster & Hadwin, 2012a) within the week following the in-class session (see Appendix B for a copy of the SERT). The purpose of the reflection was for students to become more aware of both positive and negative experiences in order to better prepare for future collaborative situations. It is important to note that this was a retrospective account of their experiences and, thus, prone to many influences that may affect the accuracy of the report (Shiffman, Stone, & Hufford, 2008). For instance, memories of an emotional event may be biased by peak moments or the final moment of that event (Kahneman & Riis, 2005). Furthermore, as more time passes and details of the event become less accessible, retrospective reports may begin to reflect individuals' general beliefs rather than their actual experience (Robinson & Clore, 2002; Shiffman et al., 2008). However, retrospective reports are useful if the purpose of the research is to understand how an emotional experience is integrated into an individual's enduring beliefs about themselves and their group, as well as how those beliefs affect their future decisions and actions (Robinson & Clore, 2002; Shiffman et al., 2008). As a case in point, Redelmeier, Katz, and Kahneman, (2003) found that patients' retrospective reports of pain better predicted their future actions than their momentary reports of pain during the

actual experience. In the context of regulated learning, students' past experiences and perceptions of those experiences become conditions for future academic tasks and situations. Thus, the individual reflection following the in-class collaborative task was a key part of the learning process for students.

The Importance of Triangulating Data Across Situational Measures. Finally, although self-report is a valid method for obtaining information about students' subjective feelings and experiences (Barrett, 2004; Larsen & Prizmic-Larsen, 2006), there are potential issues with students' ability or willingness to respond to some of the items. For instance, self-reports require respondents to have the ability to consciously attend to and recognize their emotions (Dasborough, Sinclair, Russell-Bennett, & Tombs, 2008). This is problematic if some affective reactions are unconscious (Bargh & Chartrand, 1999; Zajonc, 1980) or if an individual is simply not very attuned to his or her emotions (Dasborough et al., 2008). In addition, self-reports may not accurately reflect students' actual behaviours during a task (Winne & Jamieson-Noel, 2002). Therefore, it is important to consider additional measures to gain a more comprehensive picture of students' emotional processes (Op 't Eynde & Turner, 2006; Wosnitza & Volet, 2005). For example, in Study 2 (Bakhtiar et al., 2018), chat data were coded for different types of socio-emotional interactions (i.e., positive interactions, negative interactions, and expressing emotions) along with regulatory processes (e.g., planning, enacting, monitoring, adapting) and modes of regulation (i.e., self-, co-. and shared regulation). As with any form of measurement, chat data have some limitations for researching emotion regulation. In particular, researchers must interpret the data, which are restricted to what participants express and/or are willing to disclose through text. As a result, these data may not be an accurate or complete reflection of how students are feeling or what actions they individually take to manage those

feelings (Järvenoja et al., 2018; Wosnitza & Volet, 2005). Triangulating the data by examining multiple sources of information is therefore important for improving understandings of students' emotional experiences. For example, in Study 2 (Bakhtiar et al., 2018), we also examined self-reports of group members' current emotional states and their reflections on their emotional experiences to complement the chat data.

Emotion Regulation is Goal Directed and Adaptive

From a regulated learning perspective, the regulation of emotions is an intentional, goal-directed process in which learners metacognitively monitor and control their emotions when the need arises (Boekaerts, 1992; Boekaerts & Niemivirta, 2000; Winne & Hadwin, 2008). In other words, students adapt within or across tasks to manage emotions that may hinder or facilitate progress towards goals. During collaboration, group members (and groups) can hold and balance multiple cognitive, behavioural, motivational, and emotional goals that direct regulatory actions. Understanding those goals provides context for subsequent regulatory actions, such as when a group member suppresses an undesirable feeling, rather than expressing it to the group, in order to preserve group harmony and move forward with the task. Over time, individuals and groups may adapt by changing their tactics, goals, or standards in order to improve progress. For example, when a group member judges that suppressing an undesirable feeling is not working to reduce that feeling, this might result in a change of tactics to expressing the feeling and discussing concerns with the group. However, this key aspect of regulation (i.e., adaptation) cannot be observed without collecting data within and across tasks (Hadwin, Järvelä, et al., 2018).

These factors influenced the tools and approaches used in this dissertation research. For example, the SEST (Webster & Hadwin, 2012b, 2014) was designed to (a) capture information

about students' goals for regulating their emotions during collaboration as well as prompt strategic action and (b) span multiple time points to allow for an examination of emotion regulation as a process that unfolds both within and across tasks. More specifically, after identifying how they felt, students indicated if they would like to increase, decrease, maintain, switch, or do nothing about their feeling, and then selected a strategy from a drop-down menu for achieving that goal. Learning about students' goals (or lack thereof) for regulating their emotions helped to contextualize their strategy choices. In addition, because students completed the SEST at three times during two separate collaborative tasks, it was possible to examine how their emotions, goals, and strategies changed over time, providing evidence of change and adaptation.

Emotion Regulation Occurs in Response to Current or Anticipated Challenges

Initiating regulatory actions in the face of challenge is a key feature of regulated learning (Butler & Winne, 1995; Hadwin, Bakhtiar, & Miller, 2018; Hadwin, Järvelä, et al., 2018). As a result, emotion regulation is often viewed as a process of altering emotions that pose a challenge by interfering with progress. For instance, in Boekaerts' (Boekaerts, 1992, 1993; Boekaerts & Niemivirta, 2000) model of adaptable learning, emotion control is considered a self-regulatory skill that reduces emotions in order to help learners move away from a coping path towards a learning path.

In collaborative learning contexts, Hadwin, Järvelä, et al. (2018) posit that challenge episodes are important contexts for examining regulation, which means research examining emotion regulation in collaboration should identify and target emotionally challenging situations during collaborative tasks. Research using this approach in collaborative contexts is scarce, but is beginning to emerge, with Järvenoja and colleagues at the forefront (e.g., Ayoko et al., 2012; Järvenoja & Järvelä, 2009, 2013; Järvenoja et al., 2013; Näykki et al., 2014). For example,

Järvenoja and Järvelä (2009) and Näykki et al. (2014) examined university students' regulatory processes and strategies in response to socio-emotional challenges arising during collaborative learning. Outside of collaborative contexts, much of the existing empirical research in academic contexts tends to focus on regulating undesirable emotions in challenging situations (e.g., Op 't Eynde, De Corte, & Verschaffel, 2007; Pekrun & Linnenbrink-Garcia, 2012; Sutton, 2007). For example, Op 't Eynde et al. (2007) assessed the frequency with which secondary school students reported using coping strategies to manage their emotions in stressful math-related scenarios. In a past study, we examined university students' self-reports of regulating emotions that were interfering with progress towards their goals (Webster & Hadwin, 2015). Typically, these undesirable emotions are negative, although Wolters (2003) points out that positive emotions may interfere with progress as well. Regardless, the aim of emotion regulation from this perspective is to control one's undesirable emotions so focus can be maintained on the task at hand rather than on the interfering emotion.

Regulating undesirable emotions is undeniably important. However, emotion regulation need not focus exclusively on controlling unwanted or negative emotions. At times, it may be beneficial to maintain or increase positive emotions (Tugade & Fredrickson, 2006). For example, research indicates that strategies to elicit positive emotions, including savoring positive events, telling others about positive events, and loving-kindness meditation are related to positive outcomes such as greater self-control, life satisfaction, and happiness (Bryant, 2003; Fredrickson, Cohn, Coffey, Pek, & Finkel, 2008; Gable, Reis, Impett, & Asher, 2004). These outcomes are in line with Fredrickson's (1998; Fredrickson & Cohn, 2008) broaden-and-build theory of positive emotions, which posits that positive emotions broaden thoughts and actions (e.g., promote creative and flexible thinking) and build enduring personal resources over time

(e.g., improve coping strategies in the face of stress). In addition, research has indicated that positive emotions can be just as prevalent as negative emotions for students in individual contexts (Pekrun et al., 2002). Thus, it might be worthwhile to examine not just emotions that may interfere with progress, but also those emotions that may facilitate progress. To this end, the research in this dissertation targeted regulation of both undesirable and desirable emotions in the context of collaboration. This does not violate the assumption that regulation occurs in response to a challenge if one takes the perspective that maintaining or increasing desirable emotions is a proactive step towards avoiding or mitigating future challenges.

To examine regulation of a range of emotions in this research, the SEST (Webster & Hadwin, 2012b, 2014) allowed students to select a negative or positive emotion, evaluate that emotion as desirable (good) or undesirable (bad), and indicate how they would regulate that emotion by choosing a strategy from a drop-down list. Because the SEST gathers information at pre-determined intervals, students also had the opportunity to choose and reflect on a salient positive or negative experience via the individual reflection they complete after the collaborative task was over. In particular, the SERT (Webster & Hadwin, 2012a) prompted students to describe a positive or negative experience that occurred during the task and report their main emotion connected to that experience as well as what they did to regulate that emotion. Understanding what group members do in both negative and positive situations will provide a more comprehensive picture about emotion regulation during collaboration. For example, when groups encounter situations that elicit negative emotions and a negative socio-emotional atmosphere, much can be learned about their responses and strategies to address those challenging situations. However, focusing solely on reactions to challenges without considering how groups might engage strategies to avoid challenges could create an incomplete picture of

regulation. Examining what groups and group members do not only in negative but also positive situations may provide some insight into how groups can approach collaborative situations more proactively. Furthermore, from an instructional perspective, reflecting on past successes and difficulties can help students plan and prepare for future challenging situations.

Dual-Purpose Tools for Collecting Data on Emotion Regulation

Winne (2018) describes learners as learning scientists who need support to gather data about their own learning as well as access to strategies and opportunities to practice and experiment with those strategies. Because one aim of this dissertation is to contribute to the improvement and development of tools and interventions for supporting students to productively regulate in collaborative groups, it was important to consider not only research purposes, but also instructional purposes when designing data collection tools. Thus, both the SEST (Webster & Hadwin, 2012b, 2014) and the SERT (Webster & Hadwin, 2012a) were created with these dual purposes in mind. As a research tool, the SEST can be used to collect real-time data regarding students' emotion regulation during group work; as an instructional tool, the SEST encourages students to become aware of their emotions and to think of ways they can regulate those emotions in a short amount of time. As a research tool, the SERT can be used to collect data about students' salient experiences during the task; as an instructional tool, the SERT encourages students to reflect on past successes or difficulties so that they can adapt in future collaborative work.

It was important to consider both research and instructional purposes when making decisions about the format and content of the items on each tool. With respect to the format, the tools were constructed with measures embedded in first-person sentences to give the tools a less formal, more conversational tone. With respect to the SEST in particular, because it was

completed during a time-limited collaborative task, drop-down lists were utilized for the majority of responses in order to ease the potential burden of describing how one is feeling and figuring out what to do about it in an efficient way that would minimize disruption to the collaborative work itself. Next, I will describe some important considerations in relation to the content included in the tools.

Emotions. To assess students' emotions in both the SEST and the SERT, students chose one of 13 emotions from a drop-down list. The list included six positively valenced emotions (calm, confident, excited, focused, happy, optimistic) and seven negatively valenced emotions (anxious, disappointed, doubtful, frustrated, angry, stressed, worried). Given the limited prior research on the specific emotions students experience during collaboration, these 13 emotions were chosen for three reasons: First, they represented a balance of positive and negative emotions. As previously noted, our past research in an independent studying context indicated emotions fit better together when grouped by valence rather than both valence and activation (Webster & Hadwin, 2015). For this reason, we focused primarily on selecting emotions along the dimension of valence. Second, these emotions were among frequently reported emotions in open-ended data we have collected from students about their emotions during independent studying and/or they have been reported in the literature (e.g., Linnenbrink-Garcia et al., 2011; Pekrun & Linnenbrink-Garcia, 2012; Webster & Hadwin, 2015; Wells, 2005). Third, we chose the emotions with ecological validity in mind. That is, we chose emotions that (a) were relevant for a high-pressure collaborative testing situation and (b) would resonate with students by reflecting the language they would use in their everyday lives. For example, boredom was not included despite its prevalence in academic research (e.g., Artino & Jones, 2012; Camacho-Morles, Slemp, Oades, Morrish, & Scoular, 2019; Nett et al., 2011; Pekrun, Goetz, Daniels,

Stupnisky, & Perry, 2010; Pekrun et al., 2002; Pekrun, Hall, Goetz, & Perry, 2014) because we assumed this would be a less salient emotion in a high-evaluative situation such as the time-limited collaborative testing situation in this research (Harley, Pekrun, Taxer, & Gross, 2019). Another practical consideration was to limit the list of emotions so that (a) all emotions were visible in the drop-down list without need for scrolling and (b) students would not be overwhelmed with the number of choices.

It is important to emphasize again the novel nature of this research with little guidance as to the specific emotions students might report experiencing during online collaboration. Thus, the list of emotions is exploratory and likely does not represent all emotions that students may experience. To account for this, students also had the option to choose "other" rather than one of the emotions on the list. In addition, the SEST contained an open-text field for students to explain why they felt that way and the SERT prompted students to first describe the emotional event, providing a way to further assess the validity of their choice of emotion. Finally, I acknowledge that students may experience multiple emotions at the same time; however, students were guided to focus on one emotion in order to prompt the selection of a salient emotion that would be a good candidate for regulation.

Another key piece of information to include in a tool for measuring emotion regulation is students' evaluation of their emotion as desirable or undesirable, which guides subsequent actions (Winne & Hadwin, 2008). To reiterate a previous point, it matters less what the emotion is and more how students perceive the emotion when it comes to initiating regulatory actions. For example, although anxiety is typically considered to be unpleasant, a small amount of anxiety may actually motivate a student. In contrast, excitement is often considered a pleasant emotion, but if feeling excited distracts a student from completing a task, then this may be an

undesirable emotion that needs to be down-regulated in that moment. Thus, in the SEST, in addition to selecting an emotion from a list, students also report whether their emotion is desirable (good) or undesirable (bad). The addition of this evaluation measure contributes to the uniqueness of this tool when compared to other commonly used instruments in the literature.

Table 1 contains some examples of the variety of instruments designed to assess emotions and how they compare along several aspects such as the specific emotions included, the response format, and the context for assessment. Aside from prompting students to evaluate their emotions, the SEST also differs from other tools in the following ways: (a) it embeds the items in first-person sentences that together create a self-narrative statement for students rather than asking students to assess a list of emotions, (b) students select one salient emotion to focus on rather than rating several emotions, (c) it is administered during the task (not just before or after), and (d) it prompts students to make a plan for regulating their emotion, if desired.

Emotion regulation strategies. Similar to emotions, there is little guidance in the literature concerning the types of strategies students might use to regulate their own, each other's, and shared emotions in collaborative contexts. However, to provide students with some ideas for regulating their emotions during collaboration, a drop-down list of strategies was included in the SEST. The list was developed from existing theory and research in both individual and collaborative contexts (Gross, 1998; Järvenoja & Järvelä, 2009; Schutz et al., 2004; Webster & Hadwin, 2015). Because there are so many ways students could regulate their emotions, it would have been difficult to capture everything in a short measure. Thus, the aim in developing the drop-down list was to include a limited number of strategies for students to choose from that met the following three criteria: (a) the strategies were appropriate for the context (i.e., a computer-supported collaborative task taking place in an 80-minute time period);

(b) the strategies were specific enough to be useful, but not so specific that students could not adapt a strategy to their particular situation; and (c) the list covered the major types of strategies identified in theory and research. This resulted in a list of eight strategies, which are listed in Table 2 along with how each strategy might fit in existing frameworks. However, because there is little existing research pertaining to specific emotion regulation strategies in collaborative contexts, this aspect of the research is exploratory. As such, students have the option to choose "other" and to describe in an open-ended field what they would do to regulate their emotion. Finally, students may have no intention of deliberately regulating a particular emotion; thus, "do nothing" was also added to the list.

Whereas the SEST included a drop-down list of strategies to prompt ideas and enable students to quickly complete the tool during collaboration, the SERT included open-ended text fields for students to describe the actions they took to regulate a salient emotion. Students were prompted to describe what they did individually and what their group did, along with evaluations of each strategy in terms of its impact on their emotions and their progress. Not only did this provide research data about the specific strategies students and groups use, it also provided data for students to reflect upon and use when looking forward to future collaborative work.

Table 1. *Sample Comparison of Different Measures of Emotions*

Instrument	Emotion labels	Dimensions assessed	Targets trait or state emotions?	Response format	Context for assessment	Additional features
SEST[a]	Excited; optimistic; confident; happy; focused; calm; anxious; worried; stressed; doubtful; frustrated/angry; disappointed	Valence (positive/ negative)	State	One salient emotion selected from drop-down list; intensity selected from 5 options (*very strong, strong, moderate, weak, very weak*); items embedded in first-person sentences to create a self-narrative statement	Immediately before, during, and after synchronous computer-supported collaborative tasks	Assesses respondents' evaluation of emotion as desirable (good) or undesirable (bad); also assesses intentions and plans to regulate emotions
AEQ[b]	Enjoyment; hope; pride; relief; anger; anxiety; hopelessness; shame; boredom	Valence (positive/ negative); activation (activating/ deactivating); object focus (activity/ outcome)	Generally used to measure trait, but can be used to measure state	Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*) in relation to statements about emotions	Class-related emotions; learning-related (studying) emotions; test emotions	
GEW[c]	Pride; elation; happiness; satisfaction; relief; hope; interest; surprise; anxiety; sadness; boredom; shame/ guilt; disgust; contempt; hostility; anger	Valence (positive/ negative); control (high/ low)	State	Graphical format in shape of wheel; emotion labels situated around the outside; "spokes" made up of circles ranging in size to represent levels of intensity	Any	

OMQ[d]	Relieved; at ease; nervous; satisfied; fed up; fine; worried; confident; annoyed; concerned	Valence (positive/ negative)	State	4-point scale anchored by absence of emotion (e.g., not at ease) and presence of emotion (e.g., at ease)	Immediately before and after a learning task	Also assesses appraisals and learning intentions (pre-task) and result assessments, reported effort, and attributions (post-task)
PANAS[e]	Interested; excited; strong; enthusiastic; proud; alert; inspired; determined; attentive; active; distressed; upset; guilty; scared; hostile; irritable; ashamed; nervous; jittery; afraid	Valence (positive/ negative); activation (high to low)	Trait and state	Likert scale ranging from 1 (*very slightly or not at all*) to 5 (*extremely*)	Any	

[a]Socio-Emotional Sampling Tool (Webster & Hadwin, 2012b, 2014b). [b]Achievement Emotions Questionnaire (Pekrun et al., 2005, 2002). [c]Geneva Emotion Wheel (Scherer, 2005). [d]On-line Motivation Questionnaire (Boekaerts, 2002). [e]Positive and Negative Affect Schedule (Watson, Clark, & Tellegen, 1988)

Table 2. *Possible Classification of Strategies in Existing Frameworks of Emotion Regulation*

	Framework		
Strategy	Process model of emotion regulation (Gross, 1998)	Emotion regulation during test-taking (Schutz et al., 2004)	Target by function classification of emotion regulation strategies (Koole, 2009)[a]
Focusing on the task	Attentional deployment	Task-focusing process	Attention, goal-oriented
Creating a good plan	Situation modification	Task-focusing process	Knowledge/ attention, goal-oriented
Changing the plan or approach	Situation modification	Task-focusing process	Knowledge/ attention, goal-oriented
Changing thoughts or beliefs	Cognitive change	Regaining task-focus process; Emotion-focusing process[b]	Knowledge, goal-oriented
Thinking positively	Cognitive change	Regaining task-focus process	Attention, need-oriented/ knowledge, goal-oriented
Talking to others in the group	Situation modification	Regaining task-focus process; Emotion-focusing process	Knowledge, person-oriented
Taking deep breaths and/or relaxing	Response modulation	Regaining task-focus process	Body, person-oriented
Accepting it and carrying on	Cognitive change; Attentional deployment	Task-focusing process	Attention, person-oriented

[a]Listed in table as target, function. [b]Emotion-focusing processes include wishful thinking (e.g., I hope an answer will pop into my head) and self-blame (e.g., I blame myself for the problems I am having; Schutz et al., 2004).

Purpose, Context, and Overview of Manuscripts

The purpose of this dissertation was to explore the emotional experiences of undergraduate students working in groups to complete an online collaborative problem-solving task from a regulation of leaning perspective. Ultimately, the aim was to identify factors and supports that contribute to productive collaboration, with a focus on the socio-emotional aspect of groupwork. All four studies explored students' emotional experiences in the same context of a first-year undergraduate learning-to-learn course, described next. The first study (Manuscript 1) provides an overview of students' emotions and plans for regulating their emotions, and the remaining three studies (Manuscripts 2-4) build from there, with each subsequent study complementing and drawing upon previous findings. The following sections (a) describe the context for the research, and (b) provide an overview of each manuscript.

Research Context

The first-year learning-to-learn course, *ED-D 101: Learning Strategies for University Success*, is a semester-long, credit-bearing educational psychology course offered to undergraduate students at the University of Victoria. Broadly, the course introduces students to the theory, research, and practices associated with effective learning and motivation. It is an academic elective course taken by students across faculties and disciplines with a full range of performance grades (e.g., GPA), rather than a remedial course. The course uses a model of SRL as a framework for guiding learners to develop the knowledge and skills necessary to become productive self-regulated learners. Specifically, students are taught how to develop accurate and complete task perceptions, set productive goals, strategically choose and experiment with tactics to achieve those goals, monitor their progress, and adjust their methods as necessary. Each week, a lecture introduces SRL theory and research and an applied lab engages students in the

application of SRL theory to their own studying practice. Importantly, students are required to apply the concepts presented in lectures and reflect upon and self-evaluate learning in their other discipline-specific courses.

One aim of the course is to help students develop effective collaborative learning skills. During three semesters of data collection for this dissertation, students were assigned to groups of three to five to complete two computer-supported collaborative learning (CSCL) assignments. Conducting the assignments online fulfilled two major teaching and research purposes: (a) to provide students with the opportunity to develop virtual teamwork skills as preparation for future collaboration in this format in the workplace and (b) to document the collaborative process via chat discussions and online activity logs. Thus, the assignments were helpful in terms of teaching students relevant skills and providing both instructors and researchers with data about the process.

Each CSCL assignment comprised macro and micro scripts that guided students through the collaborative process. At the macro level, students were guided through key collaborative phases: (a) individual and group planning, (b) task enactment, and (c) reflecting in order to adapt in future collaborative work. Within each phase, students were presented with micro scripts to support progression through the phase. The order and timing of steps within the planning phase as well as the micro scripts in each phase change yearly. Table 3 contains a summary of research designs across three semesters of data collection, along with the corresponding manuscript(s). Specific details about the assignments in each semester are described in the manuscripts.

In addition, groups were assigned to different planning conditions, with the specific conditions also changing yearly. Planning is a key process of regulation, occurring prior to and during task engagement (Pintrich, 2000; Winne & Hadwin, 1998; Zimmerman, 1986). Planning

processes—including analyzing the task and developing task perceptions, setting goals, and creating strategic plans to achieve those goals—contribute to efficient and effective task completion (e.g., Greene, Hutchison, Costa, & Crompton, 2012; Rogat & Linnenbrink-Garcia, 2011; Stout, Cannon-Bowers, Salas, & Milanovich, 1999; Weingart, 1992). Miller and Hadwin (2015a) point out that learners often struggle with planning at both individual and group levels, and thus prompting and scaffolding this process is an important area for intervention. To this end, research in ED-D 101 has examined the effects of different planning scripts to determine the types of supports that will help group members and groups engage in metacognitive planning activities and effectively complete the task. Across three semesters of data collection, the planning scripts have varied along two primary dimensions: (a) the level of scripting (i.e., high vs. low guidance) provided during individual and/or group planning and (b) the use of visualizations during group planning, which summarize and display individual responses collected during solo planning with the intent to prompt discussion and negotiation among the group. Table 3 contains a summary of the different planning conditions in each semester of data collection.

Overview of Manuscripts

Table 4 contains a summary of the purpose, research questions, main data sources, and semester of data collection for each manuscript. An overview of each manuscript is described next.

Table 3. *Summary of Research Designs Across Three Semesters*

	Fall 2012	Fall 2013	Fall 2014
Manuscript	Manuscript 1 (Webster & Hadwin, 2018)	Manuscript 2 (Bakhtiar, Webster, & Hadwin, 2018)	Manuscript 3 (Webster & Hadwin, 2019) Manuscript 4 (Webster, Davis, & Hadwin, 2019)
Group assignment	Students assigned to groups within their lecture section.	Students assigned to groups within their lecture section.	Students assigned to groups within their lab section.
Conditions	**Condition A** = highly scripted solo and group planner + link in group planner to visualization summarizing solo planner responses **Condition B** = highly scripted solo and group planner + no link in group planner to visualization	**Condition A** = highly scripted solo planner + highly scripted group planner **Condition B** = loosely scripted solo planner + highly scripted group planner **Condition C** = highly scripted solo planner + loosely scripted group planner **Condition D** = loosely scripted solo planner + loosely scripted group planner	**Condition A** = quantified visualization in group planner **Condition B** = nominal visualization in group planner **Condition C** = no visualization
Macro script steps	1. Group coordinated individual expertise 2. Solo planning 3. Group planning 4. Joint challenge 5. Solo reflection	1. Group coordinated individual expertise 2. Solo planning 3. Group planning 4. Joint challenge 5. Solo reflection	1. Solo planning 2. Group planning 3. Group coordinated individual expertise 4. Joint challenge 5. Solo reflection
Expertise topics	Assignment 1: SRL & task understanding; goal setting & self-monitoring; learning & memory; cognitive processes & strategies for learning Assignment 2: regulating notetaking; regulating time; regulating reading; regulating motivation & collaboration	Assignment 1: SRL; task understanding; goal setting & self-monitoring; memory & learning processes Assignment 2: regulating time & procrastination; regulating reading & notetaking; regulating test preparation & test taking; regulating motivation & emotion	Assignment 1: SRL; task understanding; goal setting & self-monitoring; regulating time & procrastination; regulating motivation Assignment 2: SRL; memory & attention; learning & processing for meaning; regulating reading & notetaking; regulating test taking and preparation
Distribution of expertise topics	Groups chose one group member to cover each topic	Groups chose one group member to cover each topic.	Groups divided the topics however they wanted among group members.

Timing of group planning session	Assignment 1: completed during the in-class session, immediately prior to the joint challenge Assignment 2: option to complete it in advance outside of class time	Assignment 1: completed during the in-class session, immediately prior to the joint challenge Assignment 2: option to complete it in advance outside of class time	Assignments 1 and 2: completed during lab the week before the joint challenge

Table 4. *Summary of Manuscripts*

Manuscript	Manuscript 1 (Webster & Hadwin, 2018)	Study 2 (Bakhtiar, Webster, & Hadwin, 2018)	Study 3 (Webster & Hadwin, 2019)	Study 4 (Webster, Davis, & Hadwin, 2019)
Purpose	Examine university students' emotions and plans for regulating those emotions during online collaboration.	Examine the regulation of socioemotional aspects of collaboration demonstrated by two groups with contrasting socioemotional climates (positive vs. negative).	Examine the strategies students report using to regulate their emotions during an online collaborative task in the context of different group planning conditions.	Examine the link between planning and preparation prior to collaboration and patterns of emotion regulation during collaboration.
Research questions	1. What emotions do students experience immediately before, during, and after a CSCL problem-solving task? 2. What are students' goals and strategies for regulating their emotions? 3. How do students' emotions, goals, and strategies change in a second CSCL problem-solving task?	1. With what set of conditions did each group enter the collaborative task? 2. How did the observed regulatory processes, regulatory modes, and socio-emotional interactions fluctuate and interact in each group? 3. What were group members' perceptions of the collaborative experience in terms of their emotional reactions?	1. What strategies do students report using to regulate a salient emotion during an online collaborative problem-solving task? 2. How effective are strategies for regulating emotions and facilitating progress? 3. What is the impact of receiving different types of planning support on students' emotions and emotion regulation strategies?	1. What patterns of emotion regulation do well-prepared versus underprepared students demonstrate during a CSCL task and a follow-up CSCL task?
Main data sources	SEST (check-ins)	Chat transcripts; SEST; SERT (reflection); Individual planning tool and summary sheets; Group planning tool	SERT	Individual planning tool; Individual submission records; Group planning chats; SEST; SERT
Semester	Fall 2012	Fall 2013	Fall 2014	Fall 2014

Manuscript 1: Webster, E. A., & Hadwin, A. F. (2018). ***Exploring emotions and plans for emotion regulation during computer-supported collaborative problem solving.*** **Manuscript submitted for publication.**

Little research has captured students' emotions and responses to those emotions while engaged in computer-supported collaborative learning. Rather, much of the existing research has gathered data through reflections after the collaborative experience or observations of the experience (e.g., Ayoko et al., 2012; Järvenoja, Volet, & Järvelä, 2013; Linnenbrink-Garcia, Rogat, & Koskey, 2011; Näykki, Järvelä, Kirschner, & Järvenoja, 2014). Therefore, the aim of this study was to explore students' emotions and their responses to those emotions in situ.

Data were gathered during two online collaborative tasks using the Socio-Emotional Sampling Tool (SEST; Webster & Hadwin, 2012b), which was administered at the beginning, middle, and end of each collaborative task. This context-sensitive tool was developed to allow students to quickly identify a current salient emotional state and create a plan for regulating that emotion. Data examined in this study included the emotion students identified, their evaluation of that emotion as good or bad, their goal for regulating that emotion, their strategy for regulating that emotion, and the mode of regulation (individual, others, or the group).

Analysis revealed four key findings. First, positive emotions dominated students' reports, suggesting these online collaborative tasks were a positive experience for students. These positive emotions may have been a result of the macro and micro scripting provided to guide students through the planning, enacting, and reflecting phases of the tasks. Testing this hypothesis with a comparison group of students is one direction for future research. Overall, this finding highlights the need to consider not just negative emotions that are perceived as interfering with progress, but also positive emotions that are perceived as facilitating progress.

Understanding the positive experiences could help in identifying instruction and strategies for students who are encountering unhelpful emotions and negative experiences.

Second, the specific positive and negative emotions students reported shifted over time within and across tasks. For example, happiness was reported the most at the end of the session, suggesting students were satisfied with the work they had done. Anxiety and worry were reported most frequently at the beginning of the session, likely due to an unfamiliarity with the task, and stress was reported most frequently at the middle. Given the time constraints imposed for completing the task, feeling stress as time was running out at the mid-point of the session was not surprising. From one task to the next, the proportion of positive emotions at the beginning and middle of the session increased. This positive shift may be an indicator of large-scale adaptation where students were adjusting or adapting positively to the collaborative task over time. For example, students may have learned from their experience in the first task and/or developed strategies for more effectively regulating their emotions.

Third, students planned to regulate their emotions. The majority of students indicated they wanted to either maintain or increase their positive emotions or decrease their negative emotions. In contrast, very few students indicated no desire to regulate their emotions. Students also appeared to differentially select strategies depending on their goals and context. For example, in the first session, students most often planned to focus on the task when their goal was to maintain or increase a positive emotion. On the other hand, when their goal was to decrease a negative emotion, they planned to think positively to almost the same extent as focusing on the task. In the second task, focusing on the task was selected more frequently and thinking positively was selected less frequently, demonstrating a shift over time.

Finally, a fourth key finding was that students perceived emotion regulation as a shared process. Students most frequently indicated their group should enact the strategy they selected together and least frequently indicated others in their group should enact the strategy, aligning with research by Järvenoja and Järvelä (2009), who found that students indicated greater use of shared and self-regulation than co-regulation when faced with socio-emotional challenges. These findings are important considering emotion regulation is often regarded as an individual process or an other-regulated process (Boekaerts & Niemivirta, 2000; Gross, 1999; Thoits, 1996; M. Williams, 2007).

This study offered a unique perspective of students' current emotional states and plans for regulating those emotions. Findings from this study will help to improve instruction and tools for emotion regulation as well as guide future research in this area.

Manuscript 2: 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. https://doi.org/10.1007/s11409-017-9178-x

Whereas Study 1 provided an overview of students' individual emotional experiences during online collaboration, Study 2 delved into the individual and group data for two groups with different socio-emotional profiles. The purpose of this cross-case analysis was to examine the interplay of regulatory processes, regulatory modes, and socio-emotional interactions that contribute to or are influenced by emotions and socio-emotional climate perceived in the group.

Two collaborative groups were selected on the basis of group members' individual responses on the Socio-Emotional Reflection Tool (SERT; Webster & Hadwin, 2012a) for the first task. The positive climate group comprised four members who recalled a positive socio-emotional experience, whereas the negative climate group comprised four members who recalled

a negative socio-emotional experience. An array of data sources was examined and contrasted between the two groups, including their planning activities, chat data, and individual responses on the SEST. Chat data were coded on three dimensions: regulatory processes, modes of regulation, and socio-emotional interactions. Analysis included examining code fluctuations over time and overlap of codes as well as examining other relevant data sources.

Four key themes distinguishing the groups emerged from the analysis. First, incoming conditions appeared to create a foundation for a positive collaborative experience. Students in the positive climate group were overall better prepared in terms of prior knowledge of expertise topics and personal responsibility for submitting individual planning activities. These students were also exposed to a highly guided individual planning tool, whereas students in the negative climate group received a loosely guided individual planning tool. Finally, students in the positive climate group entered the task reporting predominantly negative emotions and planning to share in the regulation of those emotions, whereas students in the negative climate group reported predominantly positive emotions and planned for an individual approach to regulating those emotions. Being well-prepared and perceiving regulation as more of a shared process prior to starting the task may have promoted the productive group planning session observed in the positive group but not the negative group.

Regulation of emotions during initial group planning was the second theme. Positive interactions dominated the positive climate group's discussion, likely contributing to a brief and productive planning session. In contrast, the negative climate group's planning session was lengthy, less productive, and dominated by negative interactions. Emotions reported in the SEST at the mid-point of the task indicated productive regulation of emotions in the positive group, with most members reporting a positive emotion, but less productive regulation in the negative

group, with three group members reporting a negative emotion and the fourth member failing to complete the SEST.

The third theme suggested that negative emotions may have constrained shared adaptation in the face of a challenge. In particular, the negative climate group struggled to productively adapt when running out of time and ended up completing their work more individually than as a group. Once again, their SEST responses indicated they perceived emotion regulation as more of an individual than shared process. The positive climate group demonstrated more adaptive regulation when under time pressure, comprised of group discussion and agreement of the strategy. This collective approach aligned with their individual plans at mid-point to share in the regulation of emotions.

The fourth theme emphasized the importance of encouraging and motivational statements as an effective strategy for creating a positive climate. The co-occurrence of codes revealed that the positive climate group demonstrated a higher frequency and proportion of positive socio-emotional interactions—comprised mainly of encouraging and motivational statements—across all three modes of regulation. The proportion of encouraging interactions was less frequent in the negative climate group.

This in-depth analysis of two contrasting groups provided valuable information of the key indicators distinguishing the two groups and influenced the analysis conducted in the final two studies of this dissertation.

Manuscript 3: Webster, E. A., & Hadwin, A. F. (2019). ***Individual and group strategies for regulating emotions in online collaboration.*** **Manuscript in preparation.**

Study 3 continued to look at strategies for regulating emotions but focused on students' reflections of the strategies they enacted individually and as a group. Because little prior research

has investigated the strategies students use to regulate specific emotions during online collaborative work, this study sought to take a preliminary step towards developing an inventory of strategies and examining how students evaluate those strategies. Informed by findings from Study 2 that planning may contribute to a positive versus negative socio-emotional climate, Study 3 compared the emotion regulation processes of students in different group planning conditions.

The primary data source for this study was the Socio-Emotional Reflection Tool (Webster & Hadwin, 2012a). The SERT prompted students to first describe a positive or negative experience that occurred during the collaborative session, then identify a salient emotion during that experience, and finally describe and evaluate what they did individually and as a group to regulate that emotion. Strategy descriptions were coded using a single coding scheme that was sufficient to cover both individual (solo) and group strategies.

Although students reported a variety of strategies, the most commonly reported solo and group strategies were focusing on the task (task focus) and contributing to a positive socio-emotional climate (socio-emotional support), followed by working together to answer questions (co-constructing answers). Analysis of frequencies revealed a few differences depending on the level of regulation (e.g., solo vs. group) and the valence of emotion (positive vs. negative), suggesting students were enacting some strategies strategically.

Regarding strategy evaluations, students typically perceived their strategies to be effective in terms of regulating emotions and facilitating progress. However, students' evaluations again varied, with three key differences. First, strategies for regulating positive (vs. negative) emotions were evaluated more positively overall. Second, when focusing on helpfulness for regulating negative emotions, solo (vs. group) strategies were evaluated as

helpful by a greater proportion of students. Third, when focusing on facilitating progress, group (vs. solo) strategies were generally rated as more effective.

The final analysis in this study examined students' emotions, strategies, and evaluations in the context of group planning support. Groups were assigned to one of three group planning conditions. The quantified condition supported group planning by visually displaying the number of group members who identified each criterion or standard from the individual planning activity. The nominal condition supported group planning by visually displaying all criteria or standards identified by at least one group member during individual planning without specifying the number. Finally, groups in the no visualization condition received no visual summaries of their individual planning activity responses at all. Comparisons across conditions indicated that students in groups receiving no visualization demonstrated the greatest positive shift from one assignment to the next, suggesting the lower level of support may have prompted these students to engage in more adaptation over time.

Overall, this study provides a starting point for developing an inventory of strategies that may support students to more productively regulate during online group work. Findings from this study also provide further insight into the relation between emotion regulation and planning, indicating that different types of planning support in the form of visualizations may impact emotional processes differently over time.

Manuscript 4: Webster, E. A., Davis, S. K., & Hadwin, A. F. (2019). *Planning and emotion regulation during two online collaborative tasks.* Manuscript in preparation.

The final study arose directly from the finding in Study 2 that group members were overall better prepared in the positive climate group. The aim of Study 4 was to further examine

the impact of individual planning and personal responsibility on students' emotions and emotion regulation during online collaboration.

A purposive sample of underprepared students (n = 27) and well-prepared students (n = 32) were compared. Underprepared students demonstrated lower levels of individual preparation (task understanding and personal responsibility for submitting two solo activities on time) and relatively few contributions to the group planning chat and/or wiki. Well-prepared students demonstrated higher levels of individual preparation and relatively substantial contributions to the group planning chat and/or wiki.

Analysis of SEST and SERT data revealed some key differences between the two categories of students. First, underprepared students consistently reported more positive emotions in the SEST than well-prepared students across both tasks, although the well-prepared students reported more positive emotions in the second task compared to the first. The dominant pattern of emotions for underprepared students was to report a positive emotion at each SEST check point across both tasks. In contrast, the dominant pattern for well-prepared students varied over time within and across tasks.

Second, although emotion regulation plans reported in the SEST were similar between both categories of students, there were two differences: (a) in the first task, well-prepared students were more likely than underprepared students to plan on creating a good plan as a strategy for regulating their emotion and (b) in the second task, well-prepared students were more likely than underprepared students to plan on enacting their emotion regulation strategy individually.

Third, well-prepared students demonstrated a shift towards more positive reflections on their emotional experiences across tasks, as seen in their SERT data. Whereas underprepared

students mainly recalled positive emotions and positively evaluated their strategies across tasks, well-prepared students were more likely to recall a negative emotion in the first task and shifted to recalling more positive emotions with an increase in positive evaluations in the second task.

Finally, although both categories of students were more likely to report focusing on the task as their solo strategy, the top group strategies differed. In the first task, underprepared students most often reported co-constructing answers and socio-emotional support, followed by task focus; well-prepared students most often reported task focus followed by socio-emotional support. In the second task, the top group strategy for underprepared students was task focus and for well-prepared students was socio-emotional support. In addition, students in both preparation categories indicated the group strategy was something their group did together in both tasks, but the proportion increased for well-prepared students over time.

Overall, the findings in this study demonstrated different patterns of emotion regulation processes between underprepared and well-prepared students. Contrary to our expectations, underprepared students did not report more negative emotions, but instead reported more positive emotions than well-prepared students. However, whereas the patterns remained relatively consistent over time for underprepared students, there was more variation for well-prepared students, with a positive shift over time. This study was an important first step towards examining the relation between individual planning and preparation and emotional processes during online collaboration. With further research, these relations and different patterns may be clarified.

Ethics

Research for this dissertation was conducted as part of a larger project evaluating student learning in ED-D 101 at the University of Victoria. Participants were informed of project aims and requirements as well as the ability to withdraw participation at any point in the study. Information on consent was withheld from course instructors until after final grades were submitted. In Fall 2012, participants gave informed consent by signing the consent form. Due to low levels of participation, the consent procedure was changed in Fall 2013 to implied consent upon registering in the course. This change was implemented to address the necessity of having a complete dataset for influencing evidence-based practice and institutional decision-making about student success at the university and beyond. Students in the course benefit the most from research that accurately and adequately represents all students and their experiences. Appendices C and D contain a copy of the consent withdrawal form (used in Fall 2013/2014) and ethics certificate, respectively.

Discussion

Factors Contributing to Productive Emotion Regulation in Online Collaboration

Findings from the collection of studies in this dissertation provide insight into the factors that may impact emotions and emotion regulation in collaboration. Each study offers unique pieces of information that complement or extend other findings. The overarching factors that emerged from this research as important for productive emotion regulation in online collaboration were (a) planning and preparation may affect socio-emotional processes, (b) regulating both negative and positive emotions may be beneficial, (c) regulation should occur at individual and group levels, and (d) support should be provided for selecting and enacting helpful strategies. Figure 1 displays the factors along with the studies that contributed to the finding.

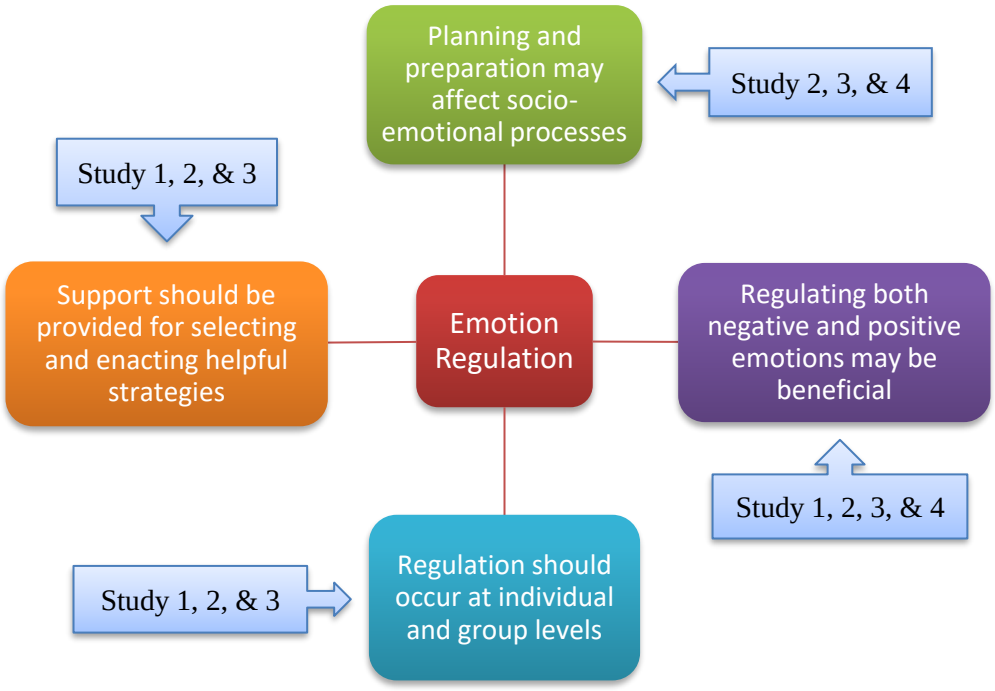

Figure 1. Overarching factors that appeared to contribute to productive emotion regulation, with studies that contributed to each factor.

Planning and preparation may affect socio-emotional processes. Planning prior to a task is commonly emphasized in models of self-regulated learning (Pintrich, 2000). In Winne and Hadwin's (1998, 2008) model, planning activities comprise the first two phases of developing task perceptions (Phase 1) and setting goals and making plans to achieve those goals (Phase 2). Productive collaboration should, therefore, involve planning at both the individual and group level (Hadwin, Bakhtiar, & Miller, 2018; Hadwin et al., 2018); however, students may need support to engage planning processes (Miller & Hadwin, 2015a). Past research examining planning support in the form of scripts and visualizations found that (a) groups completing a highly scripted group planning tool demonstrated more accurate task perceptions (Miller & Hadwin, 2015b) and (b) students in groups that received a visualization summarizing individual planning ideas reported less severe planning challenges and more success with their strategies (Hadwin, Bakhtiar, et al., 2018) Findings from this dissertation research build on those past findings to highlight a relation between planning—even when not explicitly about emotions—and subsequent socio-emotional processes during a collaborative task.

In Study 2, Bakhtiar et al. (2018) found that a group with a positive socio-emotional climate was comprised of members who were overall better prepared for the task compared to members of a group with a negative socio-emotional climate. The positive climate group demonstrated better prior knowledge of their expertise topics on course quizzes, prepared higher quality summary sheets on their expertise topics, and took personal responsibility to submit their summary sheets on time. Members of the positive climate group also completed a highly scripted individual planning tool that contained pre-stocked answers to questions about their task perceptions and goals. In contrast, members of the negative climate group completed a loosely scripted individual planning tool that contained open-ended answers to the same set of questions.

Receiving the highly scripted planning tool may have helped more members of the positive climate group to accurately assess the task and consider their goals for the task.

Finding a difference in entering conditions between the case groups in Study 2 (Bakhtiar et al., 2018) prompted further exploration of the planning phase in this dissertation. That is, Studies 3 and 4 compared emotions and emotion regulation of students who (a) received different types of group planning support (Study 3; Webster & Hadwin, 2019) and (b) were underprepared or well-prepared in terms of individual planning and preparation (Study 4; Webster et al., 2019). Findings from these two studies again revealed the important role of planning prior to enacting the task.

In Study 3 (Webster & Hadwin, 2019), groups were assigned to one of three different types of group planning support, receiving (a) a quantified visualization that summarized individual responses on the solo planner by displaying the number of group members selecting each option, (b) a nominal visualization that summarized individual responses on the solo planner by displaying which options were selected by at least one group member, or (c) no visualization. The visual summaries of individual planning responses showed groups where there were differences in individual ideas, with the intention of prompting group members to share their ideas and negotiate jointly constructed knowledge, goals, and strategies for completing the task. Two versions of the visual summaries (quantified vs. nominal) were provided to examine the effect of knowing versus not knowing how many group members had the same individual ideas. For example, groups receiving quantified information might be quick to accept a response chosen by the greatest number of group members rather than discussing and negotiating their ideas. In contrast, groups with no knowledge of how many members chose each response might

engage in a deeper discussion in order to choose which of the responses they agree upon as a group.

Findings in Study 3 (Webster & Hadwin, 2019) indicated that receiving one of the visualizations versus receiving no visualization differentially impacted group members' emotions and the effectiveness of strategies for regulating emotions; however, the impact differed across assignments. In the first assignment, there was no statistically detectable difference in the number of students recalling positive vs. negative emotions, but students in the no visualization condition rated their group emotion regulation strategies as less effective in terms of facilitating progress. This corroborates research by Hadwin, Bakhtiar, et al. (2018), who found that students in the no visualization condition reported less success with their strategies for addressing challenges faced during collaboration. Together, these findings suggest the lack of visualizations during group planning may have resulted in lower quality discussions that ultimately impacted group members' abilities to effectively use strategies during task enactment.

Over time, the impact of planning appeared to change, as demonstrated in Study 3. In the subsequent assignment, there was a positive shift for students in the no visualization condition, with those students recalling more positive emotions and rating their strategies as more effective for progress. More research is needed to understand this pattern; however, it is possible the challenges encountered in the first assignment prompted students to adapt when they worked together again, leading to a more positive experience. The difference between conditions from one assignment to the next also suggests that different planning support may be appropriate as groups work together over time and have multiple opportunities to develop more effective strategies.

Students who were individually well-prepared also demonstrated a positive shift from one task to the next in Study 4 (Webster et al., 2019). In the first assignment, these students reported more fluctuation in their emotions and recalled more negative emotions than underprepared students. However, it appears the well-prepared students may have learned from the challenges they encountered in the first assignment and adapted in the second assignment, resulting in a shift to more positive emotions and more favorable evaluations of their strategies. Underprepared students, on the other hand, demonstrated a more stable pattern of primarily positive emotions and evaluations of their strategies across assignments. We posit different explanations for this finding, including less metacognitive awareness due to poor planning, different goals or standards for their work, a social desirability bias, and culture or language differences. With more research, we may better understand how to more effectively support both groups of students.

In sum, the findings from these studies provide evidence that planning prior to a task may contribute to productive emotion regulation. Entering a task well-prepared at both an individual and group level, and then reflecting on those experiences and using that information to adapt in future tasks, appear to be key factors in impacting emotion processes and producing a positive socio-emotional climate.

Regulating negative and positive emotions may be beneficial. Across the various data sources, the regulation of not just negative but also positive emotions played a role in the emotional experiences of students. Students planned to regulate and reported strategies for regulating negative (or undesirable) emotions and positive (or desirable) emotions, as demonstrated in Studies 1 and 3 (Webster & Hadwin 2018, 2019). In addition, in Study 2 (Bakhtiar et al., 2018), the positive climate group appeared to productively regulate their initial

negative emotions, whereas the negative climate group demonstrated an apparent failure to productively regulate their initial positive emotions. Taken altogether, these findings suggest students perceive the need to regulate both types of emotions and doing so may have a positive impact on group dynamics and climate.

It is worth repeating that regulating undesirable emotions that are interfering with progress is a crucial part of productive regulation (Boekaerts, 1993; Hadwin, Järvelä, et al., 2018; Winne & Hadwin, 2008). However, findings in this dissertation suggest there is also a role for regulating desirable emotions. The broaden-and-build theory of positive emotions (Fredrickson, 1998, 2001) as well as research examining regulation of positive emotions indicates purposefully eliciting, maintaining, or increasing desirable emotions can be beneficial (Bryant, 2003; Fredrickson & Cohn, 2008; Fredrickson et al., 2008; Gable et al., 2004; Tugade & Fredrickson, 2006). Positive emotions may be particularly helpful for decision-making, flexibility, and creativity in problem-solving (Amabile, Barsade, Mueller, & Staw, 2005; Estrada, Isen, & Young, 1997; Fredrickson & Cohn, 2008; Isen, 2008; Isen, Daubman, & Nowicki, 1987; Lyubomirsky, King, & Diener, 2005; Vosburg, 1998). In groups, affective states can spread among group members, and positive emotional states have been linked to greater cooperativeness and performance (Barsade, 2002; Bramesfeld & Gasper, 2008).

Despite the potential benefits of positive emotions, Fredrickson and Cohn (2008) are careful to point out that striving to attain a consistently high level of positive emotions is not what this theory suggests. The examination in Study 4 (Webster et al., 2019) of patterns of emotions and emotion regulation processes in underprepared and well-prepared students supports this idea. Underprepared students tended to respond positively throughout the task and in their reflections after the task, whereas well-prepared students appeared to be more discerning in their

emotional responses. Responding appropriately in a challenging situation is likely an important factor to promoting subsequent productive actions. For example, when time was running out during the collaborative task, experiencing some anxiety might have motivated students to change their approach or increase focus on the task. Indeed, a few well-prepared students judged their negative emotions (often anxiety) to be good, suggesting they perceived potential benefits to feeling these activating emotions. In line with Carver and Scheier's control-process model of affect (1990), feeling negative emotions may have signaled to well-prepared students that progress was worse than expected and, therefore, action was required. On the other hand, continuously experiencing positive emotions may have indicated things were going well from the perspective of underprepared students. The potential risk of steady positive emotions is failing to notice that action, such as increased effort, is required.

Further research is needed to address the function of positive and negative emotions and their regulation in collaboration. It is likely the case that different emotions have different effects depending on the context. Thus, regulation of both positive and negative emotions should continue to be examined to determine what types of supports are appropriate for students who are learning how to collaborate effectively. Creating and maintaining a positive socio-emotional climate is important and likely involves regulating not just undesirable but also desirable emotions. However, aiming for positive emotions all the time may unnecessarily use up resources and may even result in undesirable consequences. Fluctuation in emotions across time may be indicative of greater metacognitive awareness of challenges that need to be addressed and, if appropriately responded to, could contribute to the maintenance of an overall positive and productive climate.

Regulation should occur at individual and group levels. Findings from this dissertation also point to the importance of regulating at both individual and group levels. In Study 1 (Webster & Hadwin, 2018), responses on the SEST during collaboration suggested students viewed emotion regulation as a shared process, with students most often indicating their whole group should enact the strategy they selected. The positive climate group in Study 2 (Bakhtiar et al., 2018) also entered the task with 3 of 4 group members planning to regulate their emotion together, which contrasted with the negative climate group where all four members planned to self-regulate their emotion. Furthermore, in Study 2 (Bakhtiar et al., 2018), we found evidence of shared regulatory processes when faced with a challenge in the positive group, but there was little evidence of shared regulation when faced with a challenge in the negative group. In Study 3 (Webster & Hadwin, 2019), students described enacting solo and group strategies, with favorable evaluations of both types of strategies, suggesting both may have been necessary for productive regulation.

Although self- and shared regulation were emphasized over co-regulation in students' reports, the positive group in Study 2 (Bakhtiar et al., 2018) demonstrated a higher proportion of positive socio-emotional interactions in the form of co-regulatory supports or requests compared to the negative group. In other research, Järvenoja et al. (2017) found that groups engaged in co-regulation of motivation and emotions more often than shared regulation, although the shared regulation episodes lasted longer. This suggests co-regulation also plays an important role in productive regulation (Hadwin, Järvelä, et al., 2018). When students self-report their plans and actions, they may overlook co-regulation because (a) they do not perceive an obvious difference in the two modes of regulation, (b) they view shared regulation as being more important than co-regulation, and/or (c) the individual or shared actions are more salient to students than the co-

regulatory actions. Further research into the role of co-regulation and how it fits with self- and shared regulation will shed more light on these three modes of regulation in practice.

Co- and shared regulation are key processes to productive collaboration, but this does not imply self-regulation is less important (Hadwin, Järvelä, et al., 2018). Indeed, previous research has demonstrated that self-regulatory skills positively predict group regulation (Panadero, Kirschner, Järvelä, Malmberg, & Järvenoja, 2015) and individual-level factors are key predictors of emotion regulation in online groupwork (Xu et al., 2013, 2014). My research also indicates an important role for individual processes. In Study 3 (Webster & Hadwin, 2019), students were prompted to describe and evaluate both solo and group strategies for regulating a salient emotion during a positive or negative experience. As mentioned previously, both types of strategies were evaluated favorably; however, individual strategies received higher ratings in terms of helpfulness for regulating negative emotions, whereas group strategies received higher ratings in terms of facilitating progress on the task. This provides evidence that individual and shared regulatory processes are complementary and together can contribute to more productive collaboration.

Support should be provided for selecting and enacting appropriate strategies. Järvelä et al. (2015) discuss the importance of designing CSCL tools and supports that not only prompt learners to become aware of their own (and others') learning processes but also guide learners to initiate regulatory actions. In this dissertation research, support for emotion regulation was provided in the form of tools that invited students to metacognitively monitor and evaluate their emotional processes as well as plan subsequent regulatory actions. For example, in addition to other prompts, the SEST included a pre-stocked list of strategy choices for regulating emotions. The list was intentionally developed to include strategies with the potential to help

rather than hinder students' progress. Although these specific strategies were not evaluated by students, the SERT provided students the opportunity to describe and evaluate the strategies they did enact. Together with observational data, these tools offer insight into the types of strategies that are helpful for regulation, which can inform future tool development for supporting students.

SEST and SERT data indicated a variety of strategies were planned or described for regulating emotions during collaboration, with a smaller number of strategies occurring more frequently, including focusing on the task (Studies 1 and 3; Webster & Hadwin, 2018, 2019) and providing socio-emotional support (Study 3; Webster & Hadwin, 2019). The frequent occurrence of these strategies in students' self-reports along with overall positive evaluations of their strategies (Study 3; Webster & Hadwin, 2019) suggests that students perceive these strategies to be helpful. Given the time-limited nature of the task, it is not surprising task focus was a top strategy. Focusing on the task is a core feature of Schutz et al.'s (2004) framework for regulating emotions during test taking and aligns with Gross's (1998) attentional deployment category, in which attention is directed towards a specific aspect of a situation in order to regulate emotions in that situation. Focusing on the task at hand is undoubtably necessary for efficiently and effectively completing the task but is likely not sufficient in a collaborative task where group members need to work together to complete the task. Indeed, the other commonly reported strategy of socio-emotional support appears to be a key strategy in such contexts, corroborated by observations of the two case groups in Study 2 (Bakhtiar et al., 2018). Specifically, encouragement and minimizing negative interactions were found to occur more frequently in the positive climate group than in the negative climate group, indicating these particular actions are important for productive regulation.

Although students were typically optimistic about their strategy choices, we found in Study 3 (Webster & Hadwin, 2019) that strategies for regulating positive emotions were rated as more effective than strategies for negative emotions. In addition, doing nothing was reported relatively frequently as a group strategy for regulating negative emotions. Although further research is needed to determine how students perceive this lack of action, we can speculate that taking some kind of group action is better than taking no action when faced with a challenge such as negative emotions. Altogether, these findings suggest groups may need more support to productively regulate in the face of negative emotions. For example, co-constructing answers and regulating plans / approach may be helpful for facilitating progress in addition to regulating emotions, given these are important collaborative and regulatory processes (Barron, 2003; Hadwin, Järvelä, et al., 2018; Roschelle & Teasley, 1995); however, these two strategies were reported comparatively less frequently and, thus, may be a target for intervention.

Limitations

Context. The data for this research were all collected in the same context of an online assignment, with each collaborative problem-solving task taking place during one 80-minute class session. The time limit created a specific challenge that may not be as common in other academic settings where group projects can span multiple sessions, taking place either in class or outside of class and sometimes with asynchronous communication. In addition, participants were students in a learning-to-learn course. Learning how to self-regulate their learning may have impacted their approaches and the processes they engaged. However, without this support, learners often engage in suboptimal regulation, and so examining regulatory processes as these skills are being taught is a valuable way to acquire information about effective regulation (Winne, 2005). Furthermore, although findings from this research may not generalize to other

collaborative contexts with different populations of students, the macro- and micro-scripts used in this research could be modified, if necessary, and extended to other contexts, allowing for an examination of emotions and emotion regulation of students working in groups under different conditions. As more research is done with different groups in different contexts, it will become possible to discover commonalities or discrepancies in the socio-emotional aspects that help to build the bigger picture of productive collaboration.

Exploratory nature. One aim of this dissertation was to better understand the emotional experiences and processes of students completing a computer-supported collaborative learning assignment. Given the limited research examining emotions and specific emotion regulation strategies in this context, the studies were often exploratory and descriptive in nature. Findings, however, provide a solid methodological, empirical, and theoretical foundation for designing future programs of research examining interventions and tools to support emotion regulation in groups. For example, the innovative methods employed in this study could be built upon and extended to other collaborative settings to determine if findings generalize to other populations and settings. In other words, the novel tools and approaches designed for this research are a starting point and should continue to be tested and refined over time, in a variety of contexts, and in combination with a range of data sources to validate findings and promote trustworthiness (Korstjens & Moser, 2018).

To capture students' experiences in the moment during collaboration, we designed the SEST to be a relatively short and simple self-narrative constructor tool that would allow students to quickly assess their salient emotional state and plan for regulating that emotion. In future research, this tool could be improved and used during online collaboration in different contexts. The SEST included a drop-down list of ideas for general strategies (e.g., talking to the group)

that were generated from prior research in both individual and collaborative contexts. After coding students' open-ended descriptions in the SERT, the drop-down list in the SEST could be modified to include more specific strategies identified in the SERT. For example, "talking to the group" could be broken down into strategies such as "encouraging or motivating each other" or "expressing concerns." The SEST could also prompt students to plan for individual and group strategies, rather than limiting the plan to one strategy. Finally, an important next step will be to investigate ways of sharing this information via group awareness tools in order to guide discussions and subsequent group actions.

In addition, the conceptualization of emotions and emotion regulation using Winne and Hadwin's (1998, 2008) model can guide future research questions and interpretations of findings. Viewing emotions as conditions and products of not just regulatory processes targeting emotions but also regulatory processes targeting cognitions, motivation, and behaviors emphasizes the need to consider regulation as an integrated whole. Important information about the regulation of emotions may be overlooked if researchers focus solely on processes that explicitly target emotions. For example, although jointly co-constructing an understanding of the task may not be perceived as a strategy for regulating emotions, this action may reduce the anxiety of one or more group members who previously felt unsure about the task. If students become aware of the impact of these actions, they can use this information to plan and adapt within and across tasks to alleviate emotionally challenging situations. Thus, future research should take into account non-traditional forms of emotion regulation as well as further investigate emotional products and conditions as part of broader regulatory processes.

Selection of emotions. When selecting emotions for the drop-down list in the SEST and SERT, our goal was to create a list that would resonate with students in an online collaborative

context. The choice of labels reflected the language we hear students use in their everyday lives. In addition, we also aimed to limit the number of choices in the list for efficiency. This resulted in including some emotions at the expense of excluding other emotions that may have been salient, such as the social emotions of shame and contempt. Because there is a lack of pre-existing research validating the specific emotions students experience in online collaboration, the list we developed was a starting point.

In the future, the list of emotion could be modified to reduce potentially similar emotions (e.g., anxiety, worry, and stress) and to represent a broader range of achievement, epistemic, topic, and social emotions that vary along different dimensions, such as valence and activation (Pekrun & Linnenbrink-Garcia, 2012). There are different ways to develop the list. For example, instead of a drop-down list, students could be asked to report how they feel in an open-text field or by checking off the emotions they feel from a list covering the range of emotions identified in the literature. The most frequently reported emotions could then be selected for the drop-down list in later iterations of the tools. To further enhance the validity of the tool, definitions of the emotion labels could be provided (Harley, 2015).

Single emotions. In both the SEST and SERT, students identified one emotion. The script was designed this way to help students focus on one salient aspect of the situation on which they could operate. However, students may have experienced multiple emotions at one time. For example, they may have been anxious about doing the task well, but also excited about the challenge. Because emotions are generally short-term and dynamic, instruments used in these studies did not capture the full range of emotions each student experienced during the task. Thus, the patterns of positive and negative emotions may not fully represent the breadth or interactive nature of students' emotional experiences.

Asking students to choose one emotion also limited my ability to examine emotions at a group level. Studies that examine group-level emotional states prompt participants to report on the same emotions so that responses can be combined across group members. Because students in this research were given a choice about their emotion, each member of the group could have reported a different emotion, making it difficult to assess collective emotions. It is possible group members had similar levels of positive or negative emotions, but this would not be captured if each group member focused on a different emotion, with mixed valences overall.

Importantly, for the purposes of this study, the SEST and SERT were designed with instructional and practical goals in mind. Having students choose one salient emotion allowed them to narrow their focus and complete the tool quickly and efficiently. In the future, it may be worthwhile exploring different ways of capturing students' affective states. For example, Järvenoja et al.'s (2017) S-REG tool captures information about individual group members' cognitive, motivational, and emotional states using a sliding scale to evaluate how competent they feel in that area. Using this technique allows for a quick response that immediately taps into self-evaluations of each state, which can then be combined across group members to create a visualization in the form of traffic light. If an emotional challenge is detected for at least one group member, groups see a yellow or red traffic light and are then are prompted to identify what the challenging emotion is and search for a strategy.

Evidence of strategy use. The SEST and the SERT each offers unique information about students' emotions and emotion regulation. In particular, the SEST prompted students to think about what they could do to regulate their emotions, providing valuable insight into their plans for regulation. In the SERT, students described what they did to regulate their emotions and evaluated those strategies, which allowed me to create a list of strategies and assess their overall

effectiveness. However, in each case, the reliance on self-report meant that we do not know if students actually used those strategies. For some strategies, such as taking deep breaths or thinking positively, it would have been difficult to find evidence. However, an important next step would be to corroborate students' self-reports (Winne & Hadwin, 2008), such as by examining chat data or looking for consensus among group members about what occurred. In Study 2 (Bakhtiar et al., 2018), we coded chats for two case groups and examined self-report data across group members, revealing evidence about how groups interacted and regulated. Future research should build on this finding to examine interactions and regulatory actions across larger samples, with a specific focus on corroborating self-report and observational data about emotion regulation strategies.

Analysis at the individual level. Aside from the case study (Study 2; Bakhtiar et al., 2018), the analyses used in this dissertation research were conducted at an individual level. Given that students were embedded in groups, it is important to acknowledge that some of the patterns in emotions and emotion regulation may have been influenced by the group. To address this, the approach we initially took to examine level of preparation and patterns of emotion regulation in Study 4 (Webster et al., 2019) was to identify groups containing members with high versus low levels of preparation rather than identifying individual group members with high versus low levels of preparation. This approach resulted in no discernable patterns between high and low preparation groups. It was only when we examined individual students that differences appeared. These findings suggest students' individual emotional experiences and processes may be more heavily influenced by their own individual level of preparation rather than the group's composite level of preparation. This is not to say, however, that shared planning does not play a role in students' emotional experiences. Indeed, the findings in Study 3 (Webster & Hadwin,

2019) pointed to a potential relation between group planning condition and the emotional experiences of group members.

Researching emotion regulation in online collaborative groups calls for a multi-method approach to collecting and analyzing data about self-, co-, and shared modes of regulation (Hadwin, Järvelä, et al., 2018; Järvelä et al., 2010; Järvenoja et al., 2013). That is, to more fully understand the complex regulatory processes that occur in collaborative contexts, multiple types of data should be collected from and about both individuals and groups. For example, self-reports offer insight into individuals' perceptions, beliefs, and intentions, whereas observations of groups working together or analysis of chat transcripts provide more objective data about what actually occurs during collaboration. When it comes to emotions and emotion regulation, these different types of data are insufficient on their own for fully understanding the emotional processes that occur in groups. The self-report data collected in the SEST (Webster & Hadwin, 2012b) and the SERT (Webster & Hadwin, 2012a) for this dissertation research provided valuable data about students' perceptions and intentions around strategy use. To complement these data, research could be extended to look for evidence of actual strategy use at both an individual and group level (Winne & Hadwin, 2008). Observational data, however, will not reveal individual strategies that are internal to the student—hence the importance of capturing both types of data.

Implications for Theory, Research, and Practice

Elaborating upon Winne and Hadwin's model of self-regulated learning. To date, few researchers examining emotions and emotion regulation in individual and collaborative learning contexts have drawn on Winne and Hadwin's (1998, 2008) model to guide their investigations. Thus, the use of this model to examine emotional processes in collaboration is a

unique contribution of this dissertation. Not only did it inform my perspective on this topic and my approaches to this research, it offered an opportunity to elaborate on the role of emotions in the model. Although other models of SRL exist that explicitly focus on emotions and affective processes (e.g., Ben-Eliyahu & Linnenbrink-Garcia, 2015; Boekaerts & Niemivirta, 2000; Efklides, 2011), I chose to use Winne and Hadwin's (1998, 2008) model of SRL as a framework because it offers a detailed description of the processes underlying each phase of regulation through the COPES typology, which includes emotions as conditions and products. It has also been expanded to describe regulation at multiple levels in collaboration (Hadwin, Järvelä, et al., 2018). In Study 2 (Bakhtiar et al., 2018), we attempted to elaborate on the explanation of emotions in the model, emphasizing that (a) emotions are integrated with cognitive and behavioral processes and can, therefore, be products of non-affective factors, and (b) socio-emotional interactions are viewed as observable operations, which can impact emotional products as part of a regulatory cycle. In other words, the emotional and socio-emotional aspects of working in groups can be viewed as part of, rather than separate from, regulation of collaborative learning.

Winne and Hadwin's model also differs from other SRL models by breaking down planning into two phases, emphasizing the importance of task understanding as a foundational phase that leads to setting goals and making plans (Hadwin, Bakhtiar, et al., 2018; Miller & Hadwin, 2015a). This was an important guiding point for this research as it evolved. To examine how individual planning impacts emotional processes during collaboration in Study 3 (Webster & Hadwin, 2019), we specifically considered levels of task understanding in distinguishing between well-prepared and underprepared students. Students who were underprepared had lower levels of task understanding before entering the task; this may have impacted their perceptions of

task progress, resulting in potentially inaccurate perceptions of progress or perceptions that did not align with other group members. This study therefore offers a unique contribution to understanding emotions and emotion regulation by highlighting the important role of planning, including understanding the task. Furthermore, it supports the notion that emotions are intertwined with other learning processes (Op 't Eynde & Turner, 2006; Schutz et al., 2006). When students regulate their learning, the processes they engage do not just impact their thinking or behaviors, but also their emotions. As products, these emotions then become conditions and may impact thinking, behavior, and other affective states. Studying emotions and emotion regulation as a separate process from non-affective components of learning may therefore understate the complexity and interwoven nature of learning.

Informing perceptions and measurement of emotions in collaboration. This dissertation highlights the varied and complex role of emotions in collaboration. For example, findings from Study 4 (Webster et al., 2019) suggest that negative emotions are not necessarily indicative of ill-prepared students and positive emotions are not necessarily indicative of well-prepared students. It is possible positive or negative emotions do not accurately reflect progress in a task, as emotions can be influenced by several factors, including students' appraisals or perceptions of the situation (Pekrun & Linnenbrink-Garcia, 2012), regardless of the accuracy of those perceptions. However, those perceptions and resulting emotions may lead to corresponding actions that may or may not be beneficial to the situation. Developing metacognitive awareness of one's emotions is important for fueling subsequent action (Järvelä et al., 2015), but there may be other factors to consider in effective regulation, such as the calibration between evaluations and actual progress or performance. For example, research indicates that students typically overestimate or underestimate level of performance, with lower-achieving students often

demonstrating over-confidence and higher-achieving students often demonstrating under-confidence in their predictions (Bol, Hacker, O'Shea, & Allen, 2005; Hacker, Bol, & Keener, 2008). If students' emotions reflect their over- or under-confidence, then they may perceive progress is better (or worse) than it actually is. Supporting students to more accurately assess their progress may alter their emotions and the subsequent regulatory actions they take. Future research should continue to investigate interventions to support effective emotion regulation, focusing not only on metacognitive awareness of emotions, but also on developing accurate metacognitive evaluations of regulatory processes and progress. For example, does improving perceptions of progress impact emotions and subsequent strategies chosen to regulate those emotions? How can students be supported to down-regulate or up-regulate emotions that are appropriate for the situation, given that negative emotions may be beneficial at times and positive emotions may interfere with progress at times (Muis et al., 2018)?

To answer these questions and develop a better understanding of how best to support emotion regulation in collaboration requires measurement methods that capture multiple pieces of information over time in authentic learning contexts (Järvenoja et al., 2018). For example, collecting data in situ using a tool like the SEST or through observation allows researchers to gain insight into emotional processes as they occur and how they relate to other aspects of the situation. Collecting reflection data using a tool like the SERT allows researchers to understand what information is salient in students' memory, which may impact subsequent feelings and actions in the next collaborative task. It is also important to consider how emotional processes relate to and interact with cognitive, motivational, and social processes (Järvelä, Kirschner, et al., 2016; Järvenoja et al., 2018; Rogat & Linnenbrink-Garcia, 2011). For example, findings in this dissertation suggest non-emotional processes, such as planning, may impact emotions and

emotion regulation over time. Research examining multiple aspects of collaborative learning and regulation is growing (e.g., Duffy et al., 2015; Järvelä, Järvenoja, Malmberg, Isohätälä, & Sobocinski, 2016; Järvenoja et al., 2017; Kwon, Liu, & Johnson, 2014; Lajoie et al., 2015); however, future research should further explore these relations and also consider students' metacognitive awareness of their planning, preparation, and progress.

In addition to the self-report and observation measures used in this dissertation, physiological and behavioral measures are becoming more accessible to SRL researchers. Data obtained from these measures may provide important information about affective states that participants might not otherwise report. However, these data could be difficult to interpret, especially without other contextual information about the situation and the internal feelings or perspectives of participants. Advanced learning technologies (ALTs) that capture multiple pieces of data about affective states may offer promise in this area (Azevedo, Taub, & Mudrick, 2018). For instance, individuals may be able to improve metacognitive awareness of their own affective states if they receive real-time feedback from such physiological measures in conjunction with self-report data. However, Azevedo et al. (2018) point out that "affect detection is notoriously difficult and has continued to be a problem for ALT researchers for some time…[and] most systems fail to employ system interventions or models to assist learners in regulating their affect" (p. 257). Thus, an important but challenging future direction for research is to develop and investigate tools such as ALTs that not only capture salient data but provide useful feedback and support for learners to regulate their emotions, particularly in collaborative settings. In individual learning contexts, Harley and colleagues (Harley, Bouchet, Hussain, Azevedo, & Calvo, 2015; e.g., Harley et al., 2016) have conducted research on emotion-aware ALTs to examine how learners can be supported to adaptively regulate their emotions. They have also recently

proposed a taxonomy of approaches and features for designing emotion-aware technologies that provides direction for future research (Harley et al., 2017). In group contexts, research is also emerging that examines the synchrony of physiological data and facial expressions among group members (e.g., Haataja, Malmberg, & Järvelä, 2018; Malmberg et al., 2018; Mønster, Håkonsson, Eskildsen, & Wallot, 2016). However, as research in this area grows, it will be important to keep in mind the necessity of contextualizing physiological and behavioural reactions by synchronizing these data with situational and personal factors, including the learners' interpretations and evaluations of the situation (Hadwin, Järvelä, et al., 2018). Corroborating data across multiple sources will improve the usefulness of these new technologies for understanding and supporting regulation.

Supporting socio-emotional aspects of collaboration. Three key supports for productively regulating emotions and socio-emotional aspects of collaboration can be highlighted from this dissertation: (a) planning support, (b) situated tools, and (c) reflective tools. First, planning appeared to make a difference in terms of students' emotions, the effectiveness of their strategies, and the socio-emotional climate of the group. Thus, prompting group members and groups to plan and prepare before jumping into the task is recommended. At an individual level, students may benefit from timely feedback on their planning (e.g., task understanding) and personal responsibility in order to enhance their metacognitive awareness of their own level of preparation. Xu et al. (2013, 2014) found that students who reported receiving more feedback also reported greater levels of emotion regulation in online groupwork. Although the feedback was not about planning and preparation, it would be worthwhile to examine the impact of receiving feedback specifically on planning prior to the task. In my research, students received feedback on their personal responsibility after they completed each assignment; thus, there was

opportunity to improve from one assignment to the next. However, receiving feedback on their task perceptions and their preparation and contributions to the group planning session before entering the assignment might prompt further action for those students who are less prepared. In addition to feedback on planning, students might benefit from specific planning support around socio-emotional aspects of the task. For example, they could be directed to think as individuals and as a group about how they will interact with their group during the assignment and how they might monitor their own and the group's emotional state as well as the socio-emotional climate.

In terms of group planning support, group awareness tools, such as visualizations of individual responses, appear to make a difference, but more research is needed to determine the structure of support that is most beneficial. Although providing visualizations may prompt groups to engage in more or higher quality discussion during planning, leading to more effectively implementing strategies during enactment (Hadwin, Bakhtiar, et al., 2018), my findings suggest these supports may need to change over time and/or other factors may need to be addressed in order to see positive emotional change across tasks (Webster & Hadwin, 2019).

The second type of support is to provide tools situated in the task to promote metacognitive awareness of emotions and challenges and prompt regulatory actions when needed (Järvelä et al., 2015). The SEST offered in-the-moment awareness of emotions and prompted students to think about how they could regulate those emotions. Encouraging individual awareness may have helped students recognize when things were going well—which could have resulted in greater confidence or motivation to do the task—and when things were not going well—which could have resulted in taking action to address any challenges. Going beyond individual awareness to group awareness during a collaborative task can also offer benefits. As mentioned previously, Järvenoja et al.'s (2017) S-REG tool combined individual responses to

provide a visualization of the group's current cognitive, motivational, and emotional state. Findings from their study indicated the tool prompted co-regulation of emotions and motivation at the beginning of the session. Because the tool was used only at the beginning of each collaborative session, they acknowledge implementing the tool at later timepoints may have corresponded to co-regulation later in the session as well. In addition, whereas the tool focuses on prompting co- or shared regulation of emotions, it might be beneficial to include prompts for self-regulation as well.

Finally, tools that support students to reflect on their collaborative experiences are an important factor for promoting large-scale adaptation from one collaborative task to the next. In the SERT, students had the opportunity to think about a salient experience, how they were feeling during that experience, what they did individually and as a group in response to that feeling, and how effective those strategies were. As part of the reflective process, future research might examine the impact of explicitly guiding students to (a) recognize what aspects of a challenging situation they have control over and how they can learn from that experience and change next time and (b) re-evaluate their undesirable emotions and experiences as part of the process of learning rather than an obstacle to success (Belland, Kim, & Hannafin, 2013). As Belland et al. (2013) point out, helping students to view challenges in a positive light and attributing success and failure to something in their control can lead to positive expectations for future success. The strategies from Study 3 (Webster & Hadwin, 2019) could also be provided for students as they reflect on their past experiences and plan ahead for future collaborative tasks.

The SERT was an individual tool, which allowed students to be open and honest in their reflections, but it is likely worthwhile for groups to also reflect together. In the learning-to-learn course, opportunities for group reflection were built into planning for the second task, which may

have played a role in the positive shift demonstrated in some students. For example, groups who did not receive a visualization in the first assignment may have encountered more challenges (as indicated by less favorable evaluations of their strategies), but during group planning the second time around, these groups may have reflected on those challenges and improved their planning, resulting in a better experience during the subsequent task.

Conclusion

Drawing on a regulation of learning framework, the aim of this dissertation was to develop a better understanding of the emotional experiences of students and groups during computer-supported collaborative learning. Four studies were conducted that incorporated multiple data sources to explore students' (socio-)emotional processes during group work and the relation between these and other regulatory processes. The studies built on and complemented one another to create a broader picture of emotions and emotion regulation in online collaboration. Overall, this dissertation makes three important contributions. First, by using Winne and Hadwin's (1998, 2008) model of SRL to frame the research, it afforded an opportunity to elaborate on the role of emotions and emotion regulation in that model. Second, novel tools were designed for this research to not only capture information about students' emotional processes, but also support students to productively regulate. Third, findings revealed four factors for productive regulation that can guide future research and practice.

Contribution 1. Although Winne and Hadwin's (1998, 2008) model was originally presented with a focus on cognitive processes of studying, it is a useful framework for understanding the role of emotions in collaborative learning. Drawing on the 2008 description of their model, this dissertation research further explored that role both conceptually and empirically, addressing a gap in the literature (i.e., a lack of studies using this model to research

emotional processes). Our conceptualization of emotions in the model (Study 2; Bakhtiar et al., 2018) emphasized that, when viewed as conditions, products, and operations of regulation, the emotional and socio-emotional aspects of working in groups can be viewed as part of, rather than separate from, regulation of collaborative learning. Studies 3 and 4 (Webster & Hadwin, 2019; Webster et al., 2019) further examined the relation between planning, which comprises the first two phases of the model, and subsequent emotional processes, highlighting the intricate nature of regulatory processes.

Contribution 2. Novel tools were developed for this research to capture data about students' emotions and emotion regulation both during the collaborative tasks and as students reflected on the tasks. In particular, the SEST (Webster & Hadwin, 2012b, 2014) was designed as an in-the-moment measure of current salient emotions and plans to regulate those emotions. The design of this tool was unique in that it used a self-narrative approach that prompted students to construct a personalized snapshot of their current feelings and intentions. Using a similar design, the SERT (Webster & Hadwin, 2012a) prompted students to reflect on a salient event during collaboration, then describe and evaluate the actions they took individually and as a group in response to the main emotion they experienced. These two tools not only allowed me to collect multiple pieces of data, but they encouraged students to engage in metacognitive processes intended to help them adaptively regulate their emotions both within and across tasks.

Contribution 3. Finally, four key factors for productive emotion regulation emerged from the findings. First, planning and preparation likely play a role in individual and group-level socio-emotional processes. Individual preparation prior to the task may positively impact socio-emotional climate and the pattern of individual emotional experiences and regulation over time. Planning at the group level may also impact individual emotional processes over time. However,

contrary to our expectations, students in groups that received less planning support demonstrated a greater positive change in their emotions and evaluations over time.

Second, although regulating challenging emotions is vital for progress on a task, paying attention to positive emotional experiences and considering how desirable emotions can be maintained or increased may also benefit progress. Students planned to regulate both negative and positive emotions and favourably evaluated strategies for both types of emotions, with higher evaluations when regulating positive emotions.

Third, regulating emotions should occur at both the individual and group level, in line with theory about regulatory processes in general in collaborative learning (Hadwin, Järvelä, et al., 2018). Students' plans for regulating their emotion indicated they perceived emotion regulation as a shared process. In addition, their evaluations of individual and group-level strategies for regulating emotions were typically positive, although individual strategies were judged more favourably for regulating negative emotions, whereas group strategies were judged more favourably for facilitating progress.

Fourth, individuals and groups should be supported to strategically select and enact appropriate strategies for regulating emotions. Not only were the tools used in this research designed to support productive regulation, but they also provided insight into the types of strategies students perceive as useful, such as focusing on the task and providing socio-emotional support. Observational data also offered more objective evidence of the effectiveness of actions taken by groups, indicating encouragement and minimizing negative interactions are important.

The ultimate goal of this dissertation research is to contribute to the development of tools and interventions that can support students to productively regulate in collaborative groups. Although the studies were exploratory in nature, findings provide important insight into the

emotional experiences of students and the factors that may influence productive emotion regulation. Overall, this research provides a foundational building block for future studies to further examine how best to support students with their learning and socio-emotional functioning when working in groups.

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Appendix A: Socio-Emotional Sampling Tool (SEST)

BEFORE (Time 1)

Get Ready To Collaborate

Before getting started, take a minute to get warmed up.

Your answers are not shared with the group. You will have access to your answers for your CC1 Solo Reflection Assignment

When I think about **working with my group today**, I am [anxious, calm, confident, disappointed, doubtful, excited, focused, frustrated, angry, happy, optimistic, stressed, worried, other] because_____. This feeling is [very strong, strong, moderate, weak, very weak] and I think it's [good, bad]. I would like to [increase, decrease, switch, maintain, do nothing about] this feeling by [creating a good plan, changing the plan or approach, focusing on the task, changing thoughts or beliefs, thinking positively, talking to others in the group, taking deep breaths and/or relaxing, accepting it and carrying on, doing nothing, other]. If other, please explain: _____. This is something [I should do, others in my group should do, each of us should do, we should all do together].

DURING (Time 2)

How Are Things Going?

Take a minute to individually think about how things are going before moving on to the next step in the challenge.

Your answers are not shared with the group. You will have access to your answers for the CC1 Reflection

Question 1

When I think about **how things are going with my group**, I am [anxious, calm, confident, disappointed, doubtful, excited, focused, frustrated, angry, happy, optimistic, stressed, worried, other] because_____. This feeling is [very strong, strong, moderate, weak, very weak] and I think it's [good, bad]. I would like to [increase, decrease, switch, maintain, do nothing about] this feeling by [creating a good plan, changing the plan or approach, focusing on the task, changing thoughts or beliefs, thinking positively, talking to others in the group, taking deep breaths and/or relaxing, accepting it and carrying on, doing nothing, other]. If other, please explain: _____. This is something [I should do, others in my group should do, each of us should do, we should all do together].

Question 2

The overall atmosphere in my group is [positive, negative, neutral]. I am [extremely, very, moderately, not very, not at all] satisfied with how things are going.

AFTER (Time 3)

How Did Things Go?

Now that you are finished the challenge, take a minute to individually think about how things went.

Your answers are not shared with the group

Question 1

When I think about **how things went with my group today**, I am [anxious, calm, confident, disappointed, doubtful, excited, focused, frustrated, angry, happy, optimistic, stressed, worried, other] because_____. This feeling is [very strong, strong, moderate, weak, very weak] and I think it's [good, bad].

Question 2

I am [extremely, very, moderately, not very, not at all] confident that I made a meaningful contribution to the Timed Collaborative Challenge today.

The overall atmosphere in my group was [positive, negative, neutral]. I am [extremely, very, moderately, not very, not at all] satisfied with how things went today.

Appendix B: Socio-Emotional Reflection Tool (SERT)

Question 1

Think of a **positive or negative** experience that occurred during the Timed Collaborative Challenge. Describe what happened.

Question 2

During this [positive, negative] experience, I was [anxious, calm, confident, disappointed, doubtful, excited, focused, frustrated, angry, happy, optimistic, stressed, worried]. If other, specify: _____. This feeling was [very strong, strong, moderate, weak, very weak].

What did **I** do when I felt this way? _____

- Doing this [increased my feeling, decreased my feeling, switched my feeling to something else, maintained my feeling, did not affect my feeling at all]. Therefore, doing this was [helpful, not helpful].
- Doing this made it [a lot harder, a little harder, neither harder nor easier, a little easier, a lot harder] to complete the Timed Collaborative Challenge.
- Next time, I should [do the same thing, do something different]. If different, what could I do? _____

What did **my group** do when I felt this way? _____

- This was something [my other group members did, each of us did, we all did together, N/A (my group didn't do anything)].
- Doing this [increased my feeling, decreased my feeling, switched my feeling to something else, maintained my feeling, did not affect my feeling at all]. Therefore, doing this was [helpful, not helpful].
- Doing this made it [a lot harder, a little harder, neither harder nor easier, a little easier, a lot harder] to complete the Timed Collaborative Challenge.
- Next time, my group should [do the same thing, do something different]. If different, what could my group do? _____

Appendix C: Consent Withdrawal Form

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 Moodle and WebQ;
  - ED-D 101 Moodle 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 Moodle and indicating "decline to participate". 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.

Contacts

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

- *During the course:* Dr. John Anderson (anderson@uvic.ca) or Dr. Ted Riecken (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 (***Evaluating Student Learning and the ED-D 101 Course***) 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. Your signature below indicates that you would like to withdraw your consent from research in ED-D 101.

Name	*Signature*	*Date*

Appendix D: Ethics Certificate

University of Victoria | Office of Research Services | Human Research Ethics Board
Administrative Services Building Rm B202 PO Box 1700 STN CSC Victoria BC V8W 2Y2 Canada
T 250-472-4545 | F 250-721-8960 | uvic.ca/research | ethics@uvic.ca

Certificate of Renewed Approval

PRINCIPAL INVESTIGATOR:	**Allyson Hadwin**	**ETHICS PROTOCOL NUMBER:**	**08-07-308b**
UVic STATUS:	**Faculty**	ORIGINAL APPROVAL DATE:	20-Jun-08
UVic DEPARTMENT:	**EPLS**	RENEWED ON:	13-Jun-18
		APPROVAL EXPIRY DATE:	19-Jun-19

PROJECT TITLE: **PAR-21: Promoting Adaptive Regulation for the 21st Century**

RESEARCH TEAM MEMBER: Co-principal Investigator: Dr. Phil Winne (SFU);
COLLABORATORS: Dr. Sanna Järvelä (U of Oulu), Dr. Paul Kirschner (Open University of Netherlands), Dr. Margaret-Anne Storey (UVic), Dr. Peter Wild (UVic), Dr. Daniel Dinsmore (UNF), Dr. Meghan Parkinson (UNF), Dr. Lindsay McCardle (U of Ottawa), Dr. Mariel Miller (UVic), Dr. Todd Milford (UVic);
GRADUATE STUDENTS/RESEARCH ASSISTANTS (UVic): Elizabeth Webster, Aishah Bakhtiar, Rebecca Edwards, Shayla Starcheski, Sarah Davis, Priyanka Sharma, Natalie Usher, Sarah Greco

DECLARED PROJECT FUNDING: **Learning & Teaching Centre (2017); Technology Integrated Learning (2016); SSHRC Insight Funding (2012-2016); SSHRC Insight Funding (2008-2010); CFI-LOF (2009-2013); Learning Without Borders, Learning & Teaching Centre (2013); SSHRC Insight Grant (2018 - 2023)**

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.

Rachael Scarth

Dr. Rachael Scarth
Associate Vice-President Research Operations

Certificate Issued On: 13-Jun-18

08-07-308b Hadwin, Allyson

Appendix E: Original Manuscripts

Manuscript 1: Webster, E. A., & Hadwin, A. F. (2018). *Exploring emotions and plans for emotion regulation during computer-supported collaborative problem solving.* Manuscript in preparation.

Exploring Emotions and Plans for Emotion Regulation During Computer-Supported Collaborative Problem Solving

Elizabeth A. Webster and Allyson F. Hadwin

University of Victoria

Author Note

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Abstract

This study examined university students' emotions and plans for regulating those emotions during online collaboration. In groups of three to five, 175 students completed two computer-supported collaborative problem-solving tasks. Self-report data obtained during collaboration indicated students (a) felt positive about the collaborative tasks, (b) intended to increase or maintain positive emotions and decrease negative emotions, (c) intended to focus on the task or think positively to achieve their emotion regulation goals, and (d) thought their groups as a whole should enact the emotion regulation strategies. Patterns were similar from the first task to the second, with some notable differences. These findings will help improve supports for productive emotion regulation during collaboration as well as guide future research in the area.

Keywords: emotions; emotion regulation; computer-supported collaborative learning; regulation of learning

Exploring Emotions and Plans for Emotion Regulation During Computer-Supported Collaborative Problem Solving

When done effectively, collaboration is a rewarding process that can result in beneficial outcomes (Barron, 2003; Van den Bossche, Gijselaers, Segers, & Kirschner, 2006; W. M. Williams & Sternberg, 1988). Productive collaboration, however, can be challenging. Without the appropriate skills to work together, groups may work inefficiently or fail to achieve what they set out to do, with unhappy and dissatisfied group members as a result (Chen et al., 2004; Stevens & Campion, 1994; Van den Bossche et al., 2006). To achieve desired outcomes, group members need to engage in productive regulatory processes at both individual and interpersonal levels to manage cognitions, behaviours, motivation, and emotions (Hadwin, Järvelä, & Miller, 2018; Järvelä & Hadwin, 2013). To this end, research examining regulation of learning in collaborative contexts is important for understanding how effective collaboration can be supported in groups.

One area of regulation that has been underemphasized in collaborative contexts is the regulation of emotions (Järvenoja & Järvelä, 2009; Volet & Mansfield, 2006). Group work can present a multitude of social, cognitive, and practical experiences and challenges that may impact group members' emotional states (Järvenoja & Järvelä, 2005; Järvelä, Volet, & Järvenoja, 2010; Wosnitza & Volet, 2005). In turn, these emotions may facilitate or hinder the process and, ultimately, impact the outcomes of group work (Jehn, 1997; Rogat & Linnenbrink-Garcia, 2011; Volet, Summers, & Thurman, 2009). Although research examining regulation of emotions in group work is beginning to emerge (e.g., Ayoko, Konrad, & Boyle, 2012; Järvenoja & Järvelä, 2009; Järvenoja, Järvelä, & Malmberg, 2017), little research has investigated students' emotional experiences while they are engaged in real-life learning situations, particularly during computer

supported collaborative learning (CSCL). Zirkel, Garcia, and Murphy (2015) point out that, with some exceptions, capturing experiences while they are happening in educational contexts is a relatively untapped method of research. When narrowed down to emotional experiences situated in collaborative tasks, much of the existing research has gathered data through reflections after the collaborative experience or observations of the experience (e.g., Ayoko et al., 2012; Järvenoja, Volet, & Järvelä, 2013; Linnenbrink-Garcia, Rogat, & Koskey, 2011; Näykki, Järvelä, Kirschner, & Järvenoja, 2014). Therefore, the aim of this study is to explore students' emotions and their responses to those emotions in situ.

Regulating Learning in Collaboration

Hadwin et al. (2018) posit that successful collaboration involves three modes of regulation: self-regulated learning (SRL), socially-shared regulation of learning (SSRL), and co-regulated learning (CoRL). SRL refers to goal-directed, strategic, and metacognitive engagement in learning; it involves monitoring, evaluating, and adapting cognitions, behaviors, and motivation, and affect to accomplish personal goals (Pintrich, 2000; Zimmerman, 1989, 1990). In the context of collaboration, SRL refers to individual group members regulating their own learning in the interest of shared group outcomes; SSRL refers to group members regulating together towards shared outcomes; and, CoRL refers to temporarily supporting or constraining regulatory processes of one or more group members (Hadwin et al., 2018).

Winne and Hadwin's (1998, 2008) model of SRL provides a good framework for examining self-, co-, and shared regulatory processes. Their model describes learning as a weakly sequenced, recursive process of (a) developing task perceptions, (b) creating task-specific goals and plans, (c) strategically selecting and enacting tactics to achieve goals, and (d) adapting as needed within and across tasks. Students typically follow the phases in order but can

move from one phase to any other phase as necessary. For instance, a student might realise while completing the task (Phase 3) that his understanding of the task was inaccurate, prompting him to go back and revise his task perceptions in Phase 1.

Five facets underlie each phase of the cycle, denoted by the acronym COPES: conditions, operations, products, evaluations, and standards. Internal and external *conditions* provide a context for engagement in each phase. Internal conditions are comprised of factors internal to the student, such prior knowledge, motivation, and emotions; external conditions are comprised of factors external to the student, such as task demands, resources available, and time constraints. Students cognitively process or manipulate information through *operations*, resulting in *products* in each phase, which may in turn become conditions for the next phase. For example, a student's goal is the product in Phase 2, which then becomes a condition for selecting and enacting tactics in Phase 3. Finally, students make *evaluations* of the products by comparing them to *standards*. For example, a student might decide the outline for his paper (produced in Phase 3) does not adequately meet his standard from Phase 2 of including at least three supporting points in each section. As a result of his evaluation, the student might go back and fix his outline or alter his standard.

Emotions as Conditions and Products

We view emotions as multi-componential entities that are dynamic and context-specific. Emotions can be made up of (a) affective experiences or feelings, (b) physiological responses, (c) cognitive processes, (d) behaviours or expressions, and/or (e) action tendencies (Kleinginna & Kleinginna, 1981; Scherer, 2005; Solomon, 2008). Importantly, emotions can fluctuate and change over time and context, resulting from transactions between person and environment (Efklides & Volet, 2005; Schutz, Hong, Cross, & Osbon, 2006). In educational settings, we agree

with researchers who conceptualize emotions as socially constructed and closely entwined with cognitive and motivational aspects of learning (e.g., Op ’t Eynde & Turner, 2006; Schutz et al., 2006).

In the COPES framework, emotions are considered both conditions and products. For instance, as a condition, a student’s anxiety might interfere with her ability to focus on answering a question in her assignment. When she fails to answer the question, this might result in more anxiety (a product). Although the distinction between emotions as conditions or products is not always apparent, theory and research indicate emotions play an important role in group work through connections with other important group constructs, such as socio-emotional interactions and social-behavioral engagement (Bakhtiar, Webster, & Hadwin, 2018; Duffy & Shaw, 2000; Linnenbrink-Garcia et al., 2011), conflict management (Jehn, 1997), and trust and cohesion (Dunn & Schweitzer, 2005; Jones & George, 1998; Wegerif, 1998). Capturing students’ emotions in the moment has the potential to enhance our understanding of emotions as conditions and products of regulation.

Emotions as Targets of Regulation

When students perceive the need to alter or maintain their feelings, emotions become a target for regulation (Winne & Hadwin, 2008). From this perspective, regulating emotions involves (a) being aware of and understanding emotions, (b) setting goals for regulating emotions, (c) selecting and using strategies for achieving goals, and (d) monitoring, evaluating, and adapting. In collaborative learning contexts, these processes should occur at both the individual and group level (Järvenoja & Järvelä, 2009). Although there is a growing body of research on emotion regulation in group work (e.g., Ayoko et al., 2012; Järvenoja & Järvelä, 2009; Järvenoja et al., 2017; Näykki et al., 2014), few published studies have examined emotion

regulation in computer-supported collaborative contexts from a regulation of learning perspective.

In CSCL contexts, students may perceive or enact emotion regulation differently than in face-to-face contexts due to the physical absence of their group members. Limited research suggests emotion regulation does occur in online groups as well. For example, Ayoko et al. (2012) observed group members engaging in a variety of online interactions that appeared to help resolve conflict and reduce communication of negative emotions, indicating that regulation of emotions was occurring. Observing collaborative interactions is important, but not sufficient to fully understand students' emotional experiences and intentions for regulating their emotions (Cahour, 2013). In the current study, we extend existing research to focus on students' self-reports of their emotions and plans for emotion regulation.

Examining Emotions and Emotion Regulation From an SRL Perspective

When examined from an SRL perspective, emotion regulation is often viewed as a process of altering emotions that are interfering with progress. For instance, this is a key feature of Boekaerts' (Boekaerts & Niemivirta, 2000; Boekaerts, 1992, 1993) model of adaptable learning, in which emotion control is considered a self-regulatory skill that reduces emotions in order to help learners move away from a coping path towards a learning path. Indeed, much of the existing empirical research in academic contexts tends to focus on regulating undesirable emotions in challenging situations (e.g., Järvenoja & Järvelä, 2009; Nett, Goetz, & Hall, 2011; Op 't Eynde, De Corte, & Verschaffel, 2007; Sutton, 2007; Webster & Hadwin, 2014). Typically, these undesirable emotions are negative, although Wolters (2003) points out that positive emotions may interfere with progress as well. Regardless, the aim of emotion regulation from this perspective is to control undesirable emotions.

Emotion regulation need not focus exclusively on managing unwanted or negative emotions. At times, it may be beneficial to maintain or increase positive emotions (Tugade & Fredrickson, 2006). For example, research indicates that strategies to elicit positive emotions, including savoring positive events, telling others about positive events, and loving-kindness meditation are related to positive outcomes such as greater self-control, life satisfaction, and happiness (Bryant, 2003; Fredrickson, Cohn, Coffey, Pek, & Finkel, 2008; Gable, Reis, Impett, & Asher, 2004). These outcomes are in line with Fredrickson's (1998) broaden-and-build theory of positive emotions, which posits that positive emotions broaden thoughts and actions (e.g., promote creative and flexible thinking) and build enduring personal resources over time (e.g., improve coping strategies in the face of stress; Fredrickson & Cohn, 2008; Fredrickson, 1998). Therefore, in a collaborative context, it might be worthwhile to examine not just emotions that may interfere with progress, but also emotions that may facilitate progress.

Another important aspect of emotion regulation that is often overlooked in past research is students' intentions for regulating their emotions. From an SRL perspective, goals are a key aspect of the process, helping students to select strategies and then monitor, evaluate, and adapt their progress. Knowing what goals students have for regulating their emotions offers insight into how students perceive their emotions, which may change depending on the context (Gross, 1998). For instance, increasing excitement at a social event may be an appropriate goal for a student, but decreasing excitement may be more appropriate when the student needs to concentrate on his/her homework. Alternatively, students may not perceive the need to regulate their emotions, in which case we would not expect them to consciously select strategies for regulating those emotions.

Supporting Emotion Regulation

Understanding how students view and respond to their emotions not only enhances understandings of emotion regulation, it can also shed light on appropriate interventions for improving students' regulatory abilities. For example, if students choose strategies that appear to be misaligned with their goals for regulating their emotions, this could indicate they are not engaging in effective emotion regulation. Interventions might then need to target developing better awareness of how emotions might impact learning or well-being and/or how to respond appropriately.

Järvelä and Järvenoja (2013) identify a challenge for future research to examine the effects of motivation and emotion scaffolds on regulation. To this end, Järvenoja et al. (2017) examined the use of a group awareness tool (S-REG) for supporting awareness and group regulation of emotions and motivation. The tool collects individual reports of potentially challenging emotional states during collaboration and generates a visualization of the group's emotional state in the form of a green, yellow, or red traffic light. In the current study, we also implement a tool to scaffold emotion regulation. Our tool encourages awareness of their salient feeling in the moment and provides support for regulating that feeling. Because the same emotion might have different effects under different circumstances, the tool allows students to not only report positive or negative emotions, but also to evaluate their emotions as desirable or undesirable. These evaluations are an important factor in the regulation of emotions. For example, although anxiety is considered a negative emotion, a student may view it as being beneficial in certain situations and therefore attempt to increase or maintain their current level. It is therefore important to capture students' evaluations to provide more context for their regulatory intentions and actions.

Purpose and Research Questions

The purpose of this exploratory study was to examine university students' emotions and plans for regulating those emotions during online collaboration. The following three research questions were posed: 1) What emotions do students experience immediately before, during, and after a CSCL problem-solving task? 2) What are students' goals and strategies for regulating their emotions? And 3) How do students' emotions, goals, and strategies change in a second CSCL problem-solving task?

Methods

Participants

Participants were 175 students enrolled in a first-year undergraduate course about regulating learning for academic success. Table 1 contains participant demographics. Students were from a variety of faculties, and the majority were in their first year of post-secondary education. Although all students in the course completed the measures used in this study as part of course requirements, data were included only if students had also consented to research participation.

Table 1

Demographics

	n	*M (SD)*
ED-D 101 grade (9-point scale)	170	5.7 (2.4)
Age in years	166	18.6 (2.6)
Gender		
Female	91	
Male	75	
Faculty		
Social Sciences / HSD / Education	90	
Humanities / Fine Arts	23	
Science / Engineering	35	
Business	17	

Year	
First	124
Second	25
Third and higher	9

Note. HSD = Human and Social Development.

Research Context

Data were collected from students participating in a semester-long, credit-bearing course offered to undergraduate students as an elective. Winne and Hadwin's (1998, 2008) model of SRL was used as a framework for guiding learners to develop the knowledge and skills necessary to become productive self-regulating learners. Specifically, students learned how to develop accurate and complete task perceptions, set productive goals, strategically choose and experiment with tactics to achieve those goals, monitor their progress, and make adjustments to their learning as necessary. Each week, a large-group lecture (two sections) introduced SRL theory and research and a small-group lab engaged students in the application of SRL theory to their own studying practice.

One aim of the course was to help students develop effective collaborative learning skills. Accordingly, students in each lecture section were assigned to groups of three to five to complete two computer-supported collaborative learning (CSCL) assignments. Groups were created with the intent to balance gender and English as a first language status. Each CSCL assignment was comprised of macro and micro scripts that guided students through the collaborative process. At the macro level, students were guided through a series of steps modelling effective collaboration: Step 1 – group coordinated individual expertise, Step 2 – solo planning, Step 3 – group planning, Step 4 – collaborative case analysis, and Step 5 – solo reflection. The focus of this study was on students' reported experiences during an in-class CSCL session comprised of group planning (Step 3) and the collaborative case analysis task (Step 4).

Together, the assignments accounted for 30% of students' final grade, with the group products each worth 10% and the solo reflections each worth 5%. Individual and group planning were not graded.

Measures and Procedure

Data during the in-class CSCL session were obtained via the Socio-Emotional Sampling Tool (SEST; Webster & Hadwin, 2012). The SEST is a context-sensitive self-report tool developed to assess current emotions and plans for regulating emotions. The tool is formatted with drop-down menus and brief open-ended text boxes embedded in first-person sentences, allowing students to quickly construct a self-narrative about their current emotional state (see Figure 1).

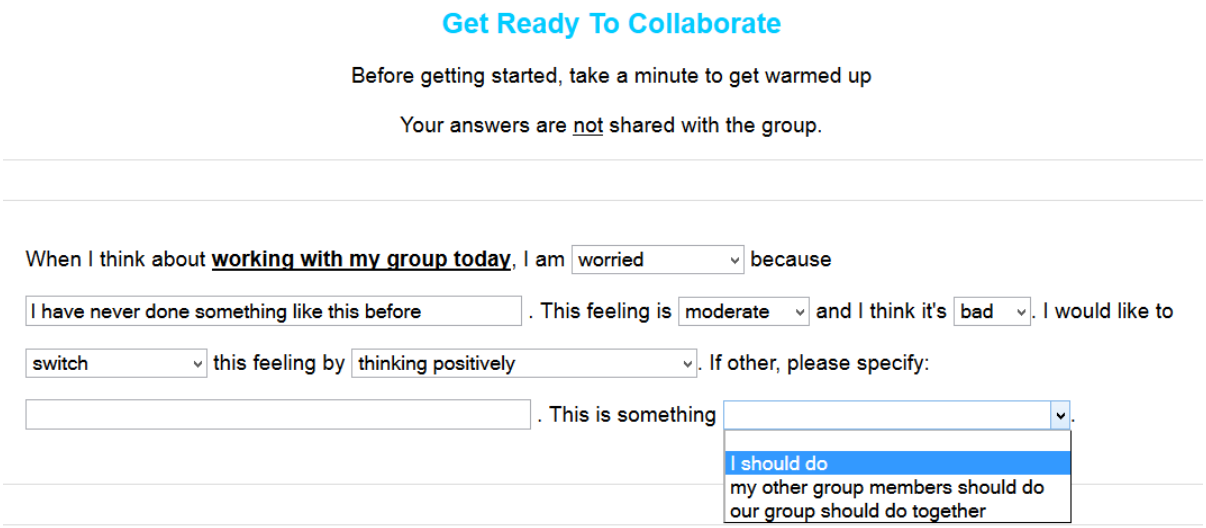

Figure 1. Sample items from the Socio-Emotional Sampling Tool.

Students completed the SEST at three times during the session (see Figure 2): (a) at the beginning of the session (Time 1), (b) after completing the first part of the case analysis task (Time 2), and (c) at the end of the session (Time 3). Following are descriptions of the specific items in the SEST that were used to collect data for this study.

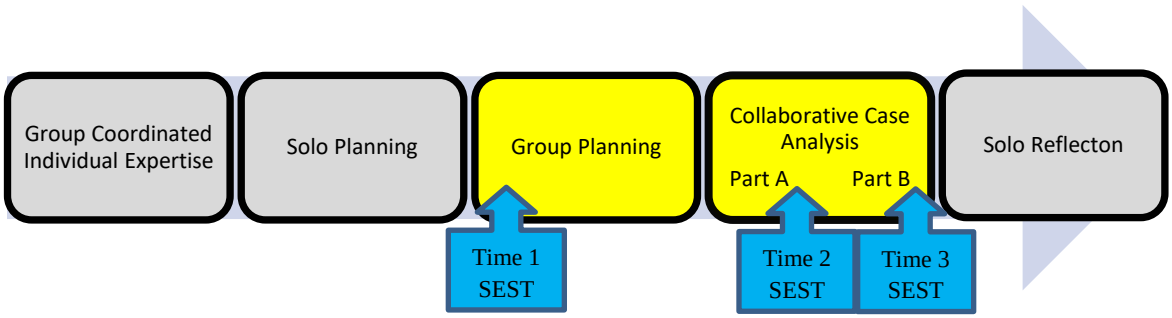

Figure 2. Timeline of data collection during the in-class CSCL session (yellow boxes). SEST = Socio-Emotional Sampling Tool.

Type of emotion. Students reported a salient emotion at the beginning (Time 1), middle (Time 2), and end (Time 3) of the in-class session by selecting one emotion from a dropdown list containing six positive emotions (excited, optimistic, confident, happy, focused, calm) and six negative emotions (anxious, worried, stressed, doubtful, frustrated/angry, disappointed). As the literature is scarce concerning specific emotions experienced during time-limited CSCL tasks, we chose these emotions on the basis of several factors. First, we examined other data we have collected from students about their emotions during independent studying. Second, we chose emotions that were relevant to the context. Third, we chose a mix of emotions typically considered positive (e.g., calm, excited) and negative (e.g., anxious, disappointed). Finally, a more practical consideration was to limit the list of emotions so that (a) all emotions were visible in the dropdown menu without need for scrolling and (b) students would not be overwhelmed with the number of choices. Note that we acknowledge students may experience multiple emotions at the same time; however, students were guided to focus on one emotion in order to prompt the selection of a salient emotion that would be a good candidate for regulation.

Intensity of emotion. After selecting one emotion, students rated how strong the emotion was on a scale from 1 (*very weak*) to 5 (*very strong*).

Evaluation of emotion. Students evaluated their emotion as desirable (*good*) or undesirable (*bad*). This was included because some emotions, although classified as positive or negative, may be more or less desirable in any given context. For example, a moderate amount of anxiety (typically considered a negative emotion) may be perceived as desirable because it focuses attention on the task at hand, whereas a high level of excitement (typically considered a positive emotion) may be perceived as undesirable because it takes attention away from the task at hand. Depending on their evaluation, students may set different goals and select different strategies to regulate their emotions.

Emotion regulation goal. Because emotion regulation is viewed as goal-directed and adaptive, the SEST includes an item tapping into students' goals or intentions for regulating their emotions. More specifically, after identifying and evaluating how they feel, students indicate if they would like to *increase*, *decrease*, *switch*, *maintain*, or *do nothing about* their feeling. Learning about students' goals (or lack thereof) for regulating their emotions should help to contextualize their strategy choices. Students responded to this item at the beginning (Time 1) and middle (Time 2) of the in-class session, but not at the end (Time 3) because the purpose of the item was to prompt regulation *during* collaboration.

Emotion regulation strategy. After identifying a goal, students indicated how they would regulate their emotion. They did this by selecting a strategy from a dropdown list of eight strategies or by describing a strategy in an open-ended field. The predefined list of strategies was developed from existing theory and research (e.g., Gross, 1998; Järvenoja & Järvelä, 2009; Schutz & Davis, 2000; Webster & Hadwin, 2014) and included the following: creating a good plan, changing the plan or approach, focusing on the task, changing thoughts or beliefs, thinking positively, talking to others in the group, taking deep breaths and/or relaxing, and accepting it

and carrying on. These strategies were selected because they were relevant to the context and covered the salient types of strategies described in existing literature. Students also had the option to choose "other" and describe an alternative strategy in an open-ended field. Finally, if students had no intention of deliberately regulating their emotion, they had the option to indicate they would "do nothing."

Mode of emotion regulation. In addition to selecting a strategy, students were also asked to indicate whether this was an action (a) for them to do on their own (SRL), (b) for their other group members to do (CoRL), or (c) for their group to do together (SSRL). This measure was included to further understand how students perceive regulation of emotions in a group setting.

Findings

To address our first two research questions, we examined frequencies of emotions, goals, and strategies reported during the first CSCL session. To address our third research question, we compared frequencies of emotions, goals, and strategies reported during the second CSCL session to the data obtained from the first session.

Types of Emotions Experienced During Online Collaboration

CSCL Session 1. Findings indicate that students generally felt good about the collaborative task and were confident in the work they had produced with their group. Table 2 displays frequencies and percentages of emotions reported at Time 1, Time 2, Time 3, and overall in CSCL Session 1. At all three time points, students reported more positive than negative emotions, with the highest percentage (83.8%) reported at the end of the session (Time 3). Of the positive emotions, confidence was most frequently reported at each time and overall. This was followed by optimism at Times 1 and 2 and happiness at Time 3. Students less

frequently reported feeling excited, focused, and calm. Of the negative emotions, anxiety was reported most frequently overall, with decreasing frequencies over time. At Time 2, when students were partway through the task and time was running out, stress was reported more often than anxiety. Feelings of frustration or anger, disappointment, and doubt were the least frequently reported emotions at each time and overall.

We also examined how closely aligned students' evaluations of their emotions were to the valence of those emotions. Table 3 shows the frequency with which students evaluated each emotion as desirable (good) or undesirable (bad). Findings indicate that students typically viewed positive emotions as good and negative emotions as bad, although the rate of discrepancy was higher for negative emotions, with 10% evaluated as good, whereas less than 1% of positive emotions were evaluated as bad.

CSCL Session 2. In the second session, students again reported more positive than negative emotions, with a greater percentage overall compared to Session 1. This was mainly due to higher percentages at Time 1 (81.0% vs. 68.4%) and Time 2 (78.6% vs. 63.7%). In addition, the positive feeling of optimism was more common in the second session compared to the first (23.7% vs. 15.9%).

Table 2

Positive and Negative Emotions Reported During CSCL Sessions 1 and 2

	Session 1								Session 2							
	Time 1		Time 2		Time 3		Session total		Time 1		Time 2		Time 3		Session total	
Emotion	*n*	%[a]	*n*	%[a]	*n*	%[a]	*n*	%[a]	*n*	%[a]	*n*	%[a]	*n*	%[a]	*n*	%[a]
Positive	**117**	**68.4**	**109**	**63.7**	**145**	**83.8**	**371**	**72.0**	**119**	**81.0**	**136**	**78.6**	**144**	**82.8**	**399**	**80.8**
Confident	34	19.9	39	22.8	44	25.4	117	22.7	21	14.3	38	22.0	40	23.0	99	20.0
Optimistic	32	18.7	25	14.6	25	14.5	82	15.9	48	32.7	37	21.4	32	18.4	117	23.7
Happy	3	1.8	17	9.9	52	30.1	72	14.0	0	0.0	15	8.7	48	27.6	63	12.8
Excited	17	9.9	9	5.3	16	9.2	42	8.2	26	17.7	15	8.7	17	9.8	58	11.7
Focused	19	11.1	11	6.4	1	0.6	31	6.0	16	10.9	19	11.0	1	0.6	36	7.3
Calm	12	7.0	8	4.7	7	4.0	27	5.2	8	5.4	12	6.9	6	3.4	26	5.3
Negative	**52**	**30.4**	**61**	**35.7**	**28**	**16.2**	**141**	**27.4**	**27**	**18.4**	**37**	**21.4**	**27**	**15.5**	**91**	**18.4**
Anxious	27	15.8	21	12.3	7	4.0	55	10.7	14	9.5	11	6.4	2	1.1	27	5.5
Stressed	7	4.1	28	16.4	6	3.5	41	8.0	11	7.5	14	8.1	8	4.6	33	6.7
Worried	18	10.5	8	4.7	6	3.5	32	6.2	2	1.4	5	2.9	8	4.6	15	3.0
Frustrated/angry	0	0.0	3	1.8	3	1.7	6	1.2	0	0.0	3	1.7	3	1.7	6	1.2
Disappointed	0	0.0	0	0.0	4	2.3	4	0.8	0	0.0	1	0.6	4	2.3	5	1.0
Doubtful	0	0.0	1	0.6	2	1.2	3	0.6	0	0.0	3	1.7	3	1.7	4	0.8
Other	2	1.2	1	0.6	0	0.0	3	0.6	1	0.7	0	0.0	3	1.7	4	0.8
Total	172	100.0	173	100.0	173	100.0	518	100.0	147	100.0	173	100.0	174	100.0	494	100.0

Note. Positive and negative emotions are listed in descending order based on overall frequencies in Session 1.

[a]Percentage of column total.

Table 3

Proportion of Emotions Evaluated as Good or Bad in CSCL Sessions 1 and 2

	Session 1					Session 2				
	Good		Bad		Total	Good		Bad		Total
Emotion	*n*	%[a]	*n*	%[a]	*n*	*n*	%[a]	*n*	%[a]	*n*
Positive	**362**	**99.2**	**3**	**0.8**	**365**	**394**	**99.0**	**4**	**1.0**	**398**
Confident	117	100.0	0	0.0	117	97	99.0	1	1.0	98
Optimistic	79	98.8	1	1.3	80	116	99.1	1	0.9	117
Happy	72	100.0	0	0.0	72	63	100.0	0	0.0	63
Excited	41	100.0	0	0.0	41	58	100.0	0	0.0	58
Focused	29	96.7	1	3.3	30	35	97.2	1	2.8	36
Calm	24	96.0	1	4.0	25	25	96.2	1	3.8	26
Negative	**14**	**10.0**	**126**	**90.0**	**140**	**6**	**6.6**	**85**	**93.4**	**91**
Anxious	9	16.7	45	83.3	54	4	14.8	23	85.2	27
Stressed	2	4.9	39	95.1	41	2	6.1	31	93.9	33
Worried	3	9.4	29	90.6	32	0	0.0	15	100.0	15
Frustrated/angry	0	0.0	6	100.0	6	0	0.0	6	100.0	6
Disappointed	0	0.0	4	100.0	4	0	0.0	5	100.0	5
Doubtful	0	0.0	3	100.0	3	0	0.0	5	100.0	5
Other	2	66.7	1	33.3	3	1	25.0	3	75.0	4
Total	378		130		508	401		92		493

Note. Positive and negative emotions are listed in descending order based on total frequencies in Session 1.
[a]Percentage of row total.

Goals and Strategies for Regulating Emotions

CSCL Session 1. Students' goals for emotion regulation in CSCL Session 1 were focused mainly on maintaining or increasing positive emotions and decreasing negative emotions (see Table 4).[1] In particular, 96.5% of the goals for regulating positive emotions were to either maintain (55.3%) or increase (41.2%) the emotion, whereas 82.1% of the goals for regulating negative emotions were to decrease the emotion. To achieve these goals, students most frequently selected the strategy of focusing on the task, followed by thinking positively (see Table 5). Focusing on the task was most predominant for maintaining (54.4%) and increasing (42.2%) emotions. When goals were to decrease emotions, students selected thinking positively

[1] Similar results were found when examining goals for regulating good vs. bad emotions.

(24.7%) to a similar extent as focusing on the task (25.8%). Further examination of strategies selected at the beginning and middle of the session revealed that students chose creating a good plan most often at the beginning of the session (see Table 6). Although chosen much less frequently overall, taking deep breaths and/or relaxing as well as changing the plan or approach were chosen more frequently partway through the session.

With respect to who should enact the selected strategies for regulating emotions, the majority of reports indicated the whole group with very few reports indicating other group members (see Table 7). Focusing on the task and creating a good plan were perceived as actions for the whole group to do in the vast majority of cases. Thinking positively and talking to others in the group were also perceived most often as actions for the whole group, but were also viewed as individual strategies to some extent.

CSCL Session 2. Similar to Session 1, students focused their goals for regulating emotions in Session 2 on increasing or maintaining positive emotions and decreasing negative emotions. Increasing emotions was chosen at a slightly higher rate than maintaining emotions in Session 2, which was the opposite in Session 1. Regarding strategies for achieving goals, the pattern was similar across both sessions, although there was (a) an increase from Session 1 to Session 2 in focusing on the task for increasing or maintaining emotions and (b) a decrease from Session 1 to Session 2 in thinking positively for all three emotion regulation goals. Finally, in Session 2 students again indicated most frequently that the strategies they chose should be enacted by the whole group, similar to Session 1. For the strategy of thinking positively, students indicated this was something the whole group should do at a higher rate in Session 2 than in Session 1.

Table 4

Goals for Regulating Positive and Negative Emotions in CSCL Sessions 1 and 2

	Session 1						Session 2					
	Positive		Negative		Overall		Positive		Negative		Overall	
Goal	*n*	%[a]	*n*	%[a]	*n*	%[a]	*n*	%[a]	*n*	%[a]	*n*	%[a]
Maintain	125	**55.3**	0	0.0	125	**37.0**	116	**45.7**	0	0.0	116	**36.5**
Increase	93	**41.2**	5	4.5	98	**29.0**	130	**51.2**	1	1.6	131	**41.2**
Decrease	4	1.8	92	**82.1**	96	**28.4**	3	1.2	58	**90.6**	61	**19.2**
Switch	2	0.9	15	**13.4**	17	5.0	3	1.2	4	6.3	7	2.2
Do nothing	2	0.9	0	0.0	2	0.6	2	0.8	1	1.6	3	0.9
Total	229	100.0	112	100.0	338	100.0	254	100.0	64	100.0	318	100.0

Note. Goals are listed in descending order based on overall frequencies in CSCL Session 1. Goals that comprise over 10% of the data for each type of emotion and overall are bolded.

[a]Percentage of column total.

Table 5

Strategies for Achieving Regulation Goals in CSCL Sessions 1 and 2

	Session 1								Session 2							
	Maintain		Increase		Decrease		Overall		Maintain		Increase		Decrease		Overall	
Strategies	*n*	%[a]	*n*	%[a]	*n*	%[a]	*n*	%[a]	*n*	%[a]	*n*	%[a]	*n*	%[a]	*n*	%[a]
Focusing on the task	68	**54.4**	42	**42.4**	25	**25.8**	135	**42.1**	75	**64.7**	76	**58.0**	16	**25.8**	167	**54.0**
Thinking positively	23	**18.4**	20	**20.2**	24	**24.7**	67	**20.9**	19	**16.4**	16	**12.2**	12	**19.4**	47	**15.2**
Creating a good plan	8	6.4	18	**18.2**	9	9.3	35	**10.9**	8	6.9	20	**15.3**	8	**12.9**	36	**11.7**
Talking to others in the group	10	8.0	12	**12.1**	9	9.3	31	9.7	4	3.4	7	5.3	5	8.1	16	5.2
Taking deep breaths and/or relaxing	0	0.0	2	2.0	13	**13.4**	15	4.7	0	0.0	1	0.8	8	**12.9**	9	2.9
Changing the plan or approach	0	0.0	2	2.0	10	**10.3**	12	3.7	0	0.0	2	1.5	3	4.8	5	1.6
Accepting it and carrying on	3	2.4	2	2.0	6	6.2	11	3.4	1	0.9	4	3.1	2	3.2	7	2.3
Doing nothing	10	8.0	0	0.0	0	0.0	10	3.1	4	3.4	4	3.1	0	0.0	8	2.6
Other	3	2.4	0	0.0	0	0.0	3	0.9	4	3.4	1	0.8	5	8.1	10	3.2
Changing thoughts or beliefs	0	0.0	1	1.0	1	1.0	2	0.6	1	0.9	0	0.0	3	4.8	4	1.3
Total	125	100.0	101	100.0	97	100.0	323	100.0	116	100.0	131	100.0	62	100.0	309	100.0

Note. Strategies are listed in descending order based on overall frequencies in CSCL Session 1. Goals for switching and doing nothing about emotions were excluded because they were selected infrequently by students (see Table 4). Strategies that comprised over 10% of the data for each goal and overall are bolded.
[a]Percentage of column total.

Table 6

Students' Strategies for Regulating Emotions Over Time in CSCL Sessions 1 and 2

	Session 1						Session 2					
	Time 1		Time 2		Overall		Time 1		Time 2		Overall	
Strategies	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Focusing on the task	64	40.5	74	53.2	138	46.5	75	54.3	94	65.3	169	59.9
Thinking positively	41	25.9	29	20.9	70	23.6	22	15.9	26	18.1	48	17.0
Creating a good plan	32	20.3	7	5.0	39	13.1	30	21.7	7	4.9	37	13.1
Talking to others in the group	17	10.8	17	12.2	34	11.4	8	5.8	10	6.9	18	6.4
Taking deep breaths and/or relaxing	4	2.5	12	8.6	16	5.4	2	1.4	7	4.9	9	3.2
Changing the plan or approach	0	0.0	13	9.4	13	4.4	1	0.7	4	2.8	5	1.8
Accepting it and carrying on	6	3.8	6	4.3	12	4.0	2	1.4	6	4.2	8	2.8
Doing nothing	2	1.3	8	5.8	10	3.4	1	0.7	8	5.6	9	3.2
Other	0	0.0	4	2.9	4	1.3	3	2.2	7	4.9	10	3.5
Changing thoughts or beliefs	3	1.9	0	0.0	3	1.0	1	0.7	3	2.1	4	1.4
Total	158	100.0	139	100.0	297	100.0	138	100.0	144	100.0	282	100.0

Note. Strategies are listed in descending order based on overall frequencies in CSCL Session 1.

Table 7

Intentions for Self-, Co-, and Shared Regulation of Emotions in CSCL Sessions 1 and 2

	Session 1							Session 2						
	SRL		CoRL		SSRL		Total	SRL		CoRL		SSRL		Total
Strategies	*n*	%[a]	*n*	%[a]	*n*	%[a]	*n*	*n*	%[a]	*n*	%[a]	*n*	%[a]	*n*
Focusing on the task	11	12.2	4	4.4	75	83.3	90	22	17.1	2	1.6	105	81.4	129
Thinking positively	18	41.9	4	9.3	21	48.8	43	12	33.3	2	5.6	22	61.1	36
Creating a good plan	3	8.6	0	0.0	32	91.4	35	3	10.0	0	0.0	27	90.0	30
Talking to others in the group	6	27.3	2	9.1	14	63.6	22	4	26.7	0	0.0	11	73.3	15
Taking deep breaths and/or relaxing	6	60.0	0	0.0	4	40.0	10	2	25.0	0	0.0	6	75.0	8
Changing the plan or approach	0	0.0	1	10.0	9	90.0	2	2	66.7	1	33.3	0	0.0	3
Accepting it and carrying on	6	66.7	0	0.0	3	33.3	9	1	14.3	0	0.0	6	85.7	7
Other	0	0.0	0	0.0	4	100.0	4	2	20.0	0	0.0	8	80.0	10
Changing thoughts or beliefs	2	66.7	0	0.0	1	33.3	3	2	50.0	0	0.0	2	50.0	4
Doing nothing	1	50.0	0	0.0	1	50.0	2	1	16.7	0	0.0	5	83.3	6
Overall	53	23.2	11	4.8	164	71.9	228	51	20.6	5	2.0	192	77.4	248

Note. Strategies are listed in descending order based on total frequencies in CSCL Session 1. SRL = self-regulated learning. CoRL = co-regulated learning. SSRL = socially shared regulation of learning.

[a]Percentage of row total.

Discussion

Positive Emotions Dominated Students' Reports

Findings from this study suggest that online collaborative work can be a positive experience for students, as indicated by the high percentage of positive emotions reported by students throughout each task. This finding was somewhat surprising, considering the potential for a situation such as a time-limited CSCL task to evoke negative feelings in students associated with themselves, the task, the technology, the context, and/or other group members (Järvenoja & Järvelä, 2005; Wosnitza & Volet, 2005). However, it is possible students were not experiencing major challenges at the time they were reporting their emotions. Alternatively, if students were experiencing challenges, they may not have had a strong enough negative reaction to them to overpower their positive feelings.

We could also speculate that one reason for students' positive experience might be the macro and micro scripting provided to guide students through the collaborative process. For example, knowing that their group members were required to prepare summary sheets and complete the solo planning tool before entering the in-class session may have put students' minds at ease. In addition, the students may have felt more confident going into the task because they personally had spent some time preparing for it. Perhaps without this kind of structure and preparation, students would have felt more apprehensive about the process, not knowing if they could rely on their group members or themselves.

There is little prior research on emotions during real-life CSCL tasks; thus, it is hard to know how the experience of group members in our study compares to that of other group members. However, past research has examined group members' satisfaction with CSCL groups, which may offer some points of comparison. For example, a meta-analysis examining the effects

of computer-mediated communication (CMC) versus face-to-face communication indicated decreased satisfaction with the group outcome and the discussion process in CMC groups (Baltes, Dickson, Sherman, Bauer, & LaGanke, 2002). A moderator analysis revealed that satisfaction in CMC groups was lower when groups were anonymous, discussion time was limited, groups were large (i.e., four or more members), and when the task was classified as an intellective and decision-making task (i.e., problem-solving tasks with verifiable answers). In our study, the CSCL task mostly met these criteria. In particular, although students used their names in the chat, they did not typically know each other; the task was completed in a limited amount of time; most groups contained four students, although some had three; and the task required students to solve a problem. On the basis of this information, we may have expected to see more negative emotions than we did. However, although Baltes et al. (2002) found that satisfaction was lower in CMC than in face-to-face groups, it was not clear how low those levels were.

Furthermore, other research examining different forms of satisfaction indicates students were generally satisfied with the collaborative experience (Dewiyanti, Brand-Gruwel, Jochems, & Broers, 2007; Zhu, 2012). For example, Dewiyanti et al. (2007) found that at the end of five distance learning courses involving asynchronous group work, students indicated they were quite satisfied with their group members, learning in a group, working in a group, and the final group product. Moreover, their analysis of messages among members of one group revealed few negative emotions and a relatively high proportion of positive emotions. In light of these past studies, our findings provide support for positive experiences associated with CSCL tasks.

Altogether, these findings highlight the need to consider not just negative emotions that are perceived as interfering with progress, but also positive emotions that are perceived as

facilitating progress. Understanding the positive experiences could help in identifying instruction and strategies for students who are encountering unhelpful emotions and negative experiences.

Emotions Shifted Over Time Within and Across Tasks

Overall, students reported more positive than negative emotions at all three time points. However, the specific emotions they reported in each category shifted slightly from time to time. For example, happiness was reported the most at the end of the session, suggesting that students were satisfied with the work they had done. This supports past research findings indicating students were generally satisfied with the collaborative experience (Dewiyanti et al., 2007; Zhu, 2012). In terms of negative emotions, anxiety and worry were reported most frequently at the beginning of the session, whereas stress was reported most frequently at the middle. These findings make sense given the context. Because students had only just begun the session at Time 1 and were unfamiliar with the task, feelings of worry or anxiety—which indicate anticipation of negative consequences (e.g., Pekrun, 2006; Zeidner, 2007)—might be expected. At Time 2, students had just completed the first part of the case analysis task and still had the second part to complete. For most groups, this occurred towards the end of the session. In fact, students were given extra time to complete the case analysis because so many groups were struggling with time. Given this situation, it is not surprising reports of stress rose at Time 2.

From the first CSCL session to the second, the proportion of positive emotions at the beginning and middle of the in-class session grew, suggesting that students entered the second session feeling better about the task than they did for the first session. We could speculate this was due to students (a) having had a positive experience in the first session and (b) having a better idea of what to expect in the second session. Another reason for the shift could be that students were regulating their emotions better the second time around. All of these reasons

would be indicative of students engaging in large-scale adaptation, or the fourth phase of Winne and Hadwin's (1998, 2008) model. In particular, the products of their engagement in the first collaborative session may have updated conditions for the second collaborative session. For example, they may have updated their perceptions of not only the task but their ability to accomplish the task, leading them to feel more confident and optimistic in the second session. In addition, they may have learned some effective strategies for dealing with their emotions in the first session, which were carried over to the second session. Regardless of the explanation, this finding is an encouraging sign that students were adjusting or adapting positively to the collaborative assignment over time.

Students Planned to Regulate Their Emotions

This study revealed that students had intentions to regulate their emotions through setting goals and selecting strategies. It is notable there were very few cases of students indicating no desire to regulate their emotion. In other words, emotion regulation appeared to be one goal for students in the CSCL task. As might be expected, their goals mainly focused on increasing or maintaining positive emotions and decreasing negative emotions. It is not surprising students wanted to enhance their well-being (e.g. Boekaerts & Corno, 2005; Boekaerts & Niemivirta, 2000); however, caution is warranted in interpreting these findings. Although students selected goals that made sense in light of their emotions, this does not necessarily mean the goals were appropriate in terms of effective collaboration or task engagement. At times, negative emotions can be helpful or unavoidable and positive emotions can be harmful in pursuit of other goals (Koole, 2009). For instance, a student's anxiety about the task may have actually served to increase his focus on the task. Reducing his anxiety in that case may have inadvertently caused him to be less engaged. Indeed, there is an argument by some organizational researchers (e.g.,

Phillips & Lount, 2007; Rhee, 2007) that negative emotions in a group may actually be beneficial in problem-solving or decision-making tasks such as the one in this study. It is therefore important for future research to further examine the effects of different types of emotions in groups.

In terms of strategies, our findings suggest that students were selecting strategies on the basis of at least two different factors: (a) their goals for regulation and (b) the context. In the first session, when students had goals to maintain or increase their emotions, they most often selected the strategy of focusing on the task. When their goal was to decrease their emotions, they selected thinking positively almost to the same extent as focusing on the task, suggesting students shifted their strategy selection in response to different goals. In addition, some strategies were selected more often at certain times. For example, changing the plan or approach was selected most often at the middle of the session, when groups presumably had a plan already in place. This strategy would make less sense at the beginning of the session when groups had yet to create their plan. A shift in strategies also occurred from one collaborative session to the next, with students selecting focusing on the task at a higher rate and thinking positively at a slightly lower rate. This shift may have occurred because students either (a) experienced success with focusing on the task in the first session or (b) recognized a need for greater focus to achieve success under the time constraints. In other words, products from the first session may have become conditions for the second session, with students perceiving value in focusing on the task as a strategy for regulating their emotions.

Students Perceived Emotion Regulation as a Shared Process

We found that students most often indicated their whole group should enact the emotion regulation strategies they individually chose. There were far fewer instances of self-regulation

and even fewer instances of co-regulation. These findings align well with research by Järvenoja and Järvelä (2009), who found that students indicated greater use of shared and self-regulation than co-regulation when faced with socio-emotional challenges. Although our study focused on strategies to regulate specific emotions and Järvenoja and Järvelä's (2009) study focused on regulating socio-emotional challenges, our findings together provide strong support that students perceive emotion regulation in collaborative contexts to be a shared process. Not only do they intend to regulate together, as we found, but they also report regulating together after the task is over, as Järvenoja and Järvelä (2009) found. This finding is important considering emotion regulation is often regarded as an individual process or an other-regulated process (Boekaerts & Niemivirta, 2000; Gross, 1999; Thoits, 1996; M. Williams, 2007).

Although this can be viewed as a positive finding suggesting students recognize the importance of sharing in the collaborative process, there is another less optimistic explanation. In particular, this may be indicative of social loafing (Karau & Williams, 1993) in the sense that group members may intend to put less effort into regulating their emotions because they feel they can distribute some of that responsibility among the group. Future research should continue to examine emotion regulation as a shared process in collaborative contexts to (a) further understand students' perceptions of the process and (b) generate evidence of shared regulatory processes actually occurring during collaboration.

Limitations and Future Research

This exploratory study has provided a wealth of information about students' emotions and plans for emotion regulation in a particular CSCL context. However, there are some limitations that should be noted. For example, we did not have a control group. For this reason, it is difficult to say (a) how representative our findings are or (b) whether there was something

about this particular group of students or the collaborative design that led to these findings. As students were in a course designed to improve their SRL knowledge and abilities, it is perhaps not surprising they indicated intentions to regulate their emotions, both positive and negative. In addition, the macro and micro scripting provided for the collaborative task may have influenced how they felt about the experience. Future research should include a control group of students who have not taken ED-D 101 and/or who are not provided the same structure for completing the collaborative task.

Another potential limitation is that all our data are self-report and focused on students' intentions for regulating emotions. Accordingly, we cannot speak to whether students followed through with their plans. That being said, self-report is the only way we can tap into students' subjective experiences (Barrett, 2004; Larsen & Prizmic-Larsen, 2006) and understand emotion regulation from their perspective. Furthermore, helping students to become aware of their own feelings and to think about how they can strategically engage in and adapt to challenging situations is a crucial part of developing better regulatory skills. Eventually these self-report data can be combined with other evidence of emotion regulation as well as its relations to other group processes and outcomes to enhance understandings of productive emotion regulation in collaborative contexts.

Findings from this study are also useful for guiding further development of the SEST. We found that students tended to choose a limited number of responses most often. Thus, it is possible some response choices need to be revised or could be dropped altogether. For example, the strategy of changing thoughts or beliefs was not chosen very often. On the other hand, thinking positively was the second most frequently chosen strategy. Because these are similar strategies, it may not be necessary to retain the former, or the two strategies could be combined

into one choice. As another example, focusing on the task was selected most often. This is a relatively broad strategy that could be implemented in different ways. Although students intended to use the strategy, they may not have had a good idea of how to enact it. Thus, one option might be to make focusing on the task a general category, with more specific strategies within that category, such as taking deep breaths or thinking positively about the situation (Schutz & Davis, 2000; Schutz et al., 2006).

Because the current study examined all the constructs at a whole-class level, future research could examine patterns of emotions, goals, and strategies over time within individual students. This would allow us to look for evidence of change in students' emotions following certain strategies (e.g., did students' negative emotions change to positive after indicating they would focus on the task or think positively?). We could compare students who reported mainly negative emotions to those who reported mainly positive emotions to look for differences in regulation over time. In addition, we can test our hypothesis that planning and preparation may impact students' emotional experiences in collaboration. In a qualitative case study of two groups with contrasting socio-emotional climates, Bakhtiar et al. (2018) found that better individual preparation prior to the collaborative task may have contributed to a positive socio-emotional climate. Future research could therefore examine the effects of individual preparation on emotions and emotion regulation at a larger scale.

As these data were collected from students in collaborative groups, it is important to consider emotion regulation at the small-group level as well. For example, we could examine chat logs and computer trace data to look for evidence of self-, co-, and shared regulation of emotions to support or extend findings from the self-reports. As Winne and Hadwin (2008)

suggest, it is important to go beyond learners' intentions for regulation and examine their subsequent actions to (in)validate those intentions.

Conclusion

This study examined university students' emotions and plans for regulating emotions during two synchronous CSCL problem-solving tasks. Frequencies indicated that students (a) felt positive about the collaborative tasks, with feelings of confidence and optimism dominating, (b) intended to increase or maintain positive emotions and decrease negative emotions, (c) intended to focus on the task or think positively to achieve their emotion regulation goals, and (d) thought their groups as a whole should enact the emotion regulation strategies. These patterns were similar from the first CSCL session to the second, with some notable differences such as (a) students reported more positive emotions in the second session than in the first and (b) students selected focusing on the task as a strategy more often in the second session than in the first. With further analyses and research, these data will help to improve instruction and tools for emotion regulation as well as guide future research in this area.

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Regulation and Socio-Emotional Interactions in a Positive and a Negative Group Climate

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Abstract

Collaboration in an online environment can be a socially and emotionally demanding task. It requires group members to engage in a great deal of regulation, where favourable emotions need to be sustained for the group's productive functioning. The purpose of this cross-case analysis was to examine the interplay of two groups' regulatory processes, regulatory modes, and socio-emotional interactions that contribute to or are influenced by emotions and socio-emotional climate perceived in the group. Specifically, this study compared a group of 4 students unanimously reporting a positive climate to a group of 4 students unanimously reporting a negative climate after completing a 90-minute online text-based collaborative assignment. By drawing on two data channels (i.e., observed regulatory actions and socio-emotional interactions during collaboration and self-reported data about emotional beliefs and perceptions), four contrasting group features emerged: (a) incoming conditions served as a foundation for creating a positive collaborative experience, (b) regulation of emotions during initial planning, (c) negative emotions served as a constraint for shared adaptation in the face of a challenge, and (d) encouragement and motivational statements served as effective strategies for creating a positive climate. Implications for researching and supporting emotion regulation in collaborative learning are discussed.

Keywords: Cross-case analysis; Computer-supported collaborative learning; Regulation; Socio-emotional interactions; Emotions

Introduction

The ability to work well in a group is a highly valued and sought-after 21st century learning skill (Partnership for 21st Century Learning 2007). A growing emphasis on virtual teamwork in the workplace (Martins et al. 2004) makes learning to collaborate in online environments an important skill for university students to attain. Productive collaboration is a complex and challenging process requiring teams to leverage diverse expertise to optimize knowledge construction and output. Regulatory processes such as planning, monitoring, and adapting are touted as critical for facilitating productive collaborative learning outcomes (Hadwin et al. 2011). Furthermore, because these regulatory processes occur in a social context, interpersonal processes should also be taken into account when examining factors that contribute to productive collaboration (Barron 2003; Van den Bossche et al. 2006). Although performance is commonly used as an indicator of productive collaboration, another important indicator is group members' perceptions of their experience, as these perceptions are carried forward as beliefs and knowledge informing approaches to future collaborative work. This study aims to contribute to a growing literature examining both regulatory and social processes in the context of group work. We compare two groups with contrasting collaborative experiences, focusing on how socio-emotional interactions as embedded in regulatory actions contribute to each group's perceived socio-emotional climate over the course of an online collaborative assignment.

Regulating Learning in Collaboration

Regulatory processes. Theoretical frameworks describing regulation in the context of social learning are still at their nascent stage. With conceptions of self-regulated learning (SRL) as a foundation, researchers are beginning to define other social forms of regulation occurring in highly dynamic and interactive learning situations such as collaboration (Hadwin et al. 2011;

Järvelä and Hadwin 2013; Järvelä et al. 2008; McCaslin and Good 1996). For example, Hadwin et al. (2011) draw heavily from Winne and Hadwin's (1998, 2008) SRL model, in which regulation of learning is conceptualized as unfolding over four loosely sequenced and recursive phases: (a) task understanding, in which learners construct a mental representation of the task; (b) goal setting and planning, in which learners set goals and strategize to meet task demands; (c) task enactment, in which learners enact tactics to achieve goals; and (d) small- and large-scale adaptation, in which learners strategically adapt task perceptions, goals, and engagement within and across tasks. At the core of the recursive cycle is metacognitive monitoring—a process necessary to evaluate and make strategic changes to learning. In this paper, we refer to the actions of planning (encompassing the first two phases), enacting, adapting, and monitoring as fundamental *regulatory processes*, which are necessary for effective learning. Winne and Hadwin (1998, 2008) also emphasize each phase of SRL shapes and is shaped by five recursively cycling features referred to as a COPES (conditions, operations, products, evaluations, and standards). The COPES architecture, catalyzed by metacognitive monitoring, underlies each phase of regulation and guides transition across phases. Internal and external *conditions* provide a context for engagement in each regulatory phase. Internal conditions are comprised of factors internal to the student or group, such as prior knowledge, motivation, and emotions. In contrast, external conditions are comprised of factors external to the student or group, such as task demands, resources available, and time constraints. Students cognitively process or manipulate information through *operations*, resulting in *products* in each phase, which may in turn become conditions for the next phase (e.g., the product of task understanding in the first phase becomes a condition for setting goals in the second phase). Finally, students construct judgments or *evaluations* of the products by comparing them to set or perceived *standards*.

Modes of regulation. Contemporary perspectives of collaboration expand on prior work by emphasizing the role of three *modes of regulation* in productive collaboration, including self-regulated learning (SRL), co-regulated learning (CoRL), and socially-shared regulation of learning (SSRL; Hadwin et al. 2011; Hadwin et al. 2017; Järvelä and Hadwin 2013; Miller and Hadwin 2015a; Winne et al. 2013). SRL refers to a goal-directed process of planning, monitoring, and adapting cognitions, behaviors, motivation, and emotions in order to accomplish individual learning goals (Pintrich 2000; Zimmerman 1989, 1990). CoRL refers to individuals or groups temporarily supporting or influencing one or more team members' regulatory processes. Finally, SSRL refers to group members collectively negotiating and realigning or adapting group regulation processes in the service of a shared outcome. All three modes of regulation are vital in collaboration and can unfold in tandem while members are working alongside each other (Hadwin et al. 2011). Consequently, conditions, operations, products, evaluations, and standards (COPES) within collaborative contexts not only extend beyond an individual, but also dynamically interact across various regulatory modes. Importantly, the COPES-based model of regulation extended to co-regulation and shared regulation recognizes behavior, motivation, cognition, and emotions are conditions and products of regulation fueled by metacognitive knowledge, beliefs, and processes. Awareness or meta-knowledge of behavioral, cognitive, motivational, and emotional states as well as desired targets fuels regulatory action.

One underemphasized aspect of regulation in collaborative contexts is the regulation of motivation and emotion (Dillenbourg et al. 2009). Students assigned to work in groups can experience a range of emotions connected to themselves, the task itself, the task context or environment, one or more other group members, or the group's collective strategies as a whole (Järvenoja and Järvelä 2005; Wosnitza and Volet 2005). Regardless of the source, emotions may

facilitate or hinder the collaborative process and, ultimately, the cognitive, behavioral, and motivational outcomes of group work. Research indicates affect plays an important role in group work, with positive affect typically associated with beneficial outcomes such as engagement and higher levels of performance and satisfaction (Jehn 1997; Rogat and Linnenbrink-Garcia 2011; Volet et al. 2009). Negative affect, if strong and persistent, is typically associated with detrimental outcomes such as withdrawal and lower levels of performance and satisfaction (Chiu and Khoo 2003; Duffy and Shaw 2000; Linnenbrink-Garcia et al. 2011; Näykki et al. 2014). Thus, in addition to regulating cognitions and behaviors, the ability to regulate helpful or harmful emotions in a group setting may contribute to productive collaboration.

COPES in Group Regulation of Emotions

The COPES architecture described by Winne and Hadwin (1998, 2008) provides an ideal context for explaining how emotion regulation occurs within collaboration because the model takes into account micro-elements of regulation that are external and internal to the regulator. Figure 1 demonstrates where the constructs specific to this study can be found within an individual's or the collective group's COPES cognitive features. We first provide an overview of Figure 1, followed by a more detailed discussion of the main constructs examined in this study.

Overview. Individuals and groups enter each collaborative work session with a set of internal and external conditions, which set the stage for self-, co-, and shared regulation of learning. As individual members and groups as a whole move in and out of regulatory processes at the macro level (i.e., planning, enacting, and adapting), they create cognitive, behavioral, and affective products via the operations they engage. After being monitored and evaluated against set or perceived standards, these products then become conditions, influencing subsequent regulatory actions. In this study, we were specifically interested in the conditions and operations

that led to the emotional product and subsequent condition of socio-emotional climate. As shown in Figure 1, we posit conditions and operations should not be limited to affective processes. Rather, we extended our investigation to include cognitive and behavioral processes because these may also create emotional products. During collaborative learning, however, there may be situations that call for an increased focus on the emotional aspects of regulation. In these situations, individuals and groups may enact various strategies (instantiations of operations) to specifically manage their emotions and create or maintain a productive socio-emotional climate. In a text-based online environment, we view socio-emotional interactions among group members (e.g., politely acknowledging contributions) as observable operations; the products of manipulating these interactions may include renewed emotions and a positively or negatively enriched socio-emotional climate. Thus, in addition to a broader examination of the regulatory processes and modes engaged by the groups at the macro level, we specifically examined the nature of each group's socio-emotional interactions embedded within the micro elements of COPES. We view socio-emotional interactions as part of—rather than separate from—regulatory cycles because those interactions are assumed to serve the purpose of regulating emotions in social contexts. Finally, group members make judgments or evaluations of their emotional experiences during collaboration by comparing emotional products with perceived standards. Emotional products during and after collaboration play an important role in future collaboration (in this task or beyond; with this group or beyond) because they are conditions informing subsequent regulatory cycles.

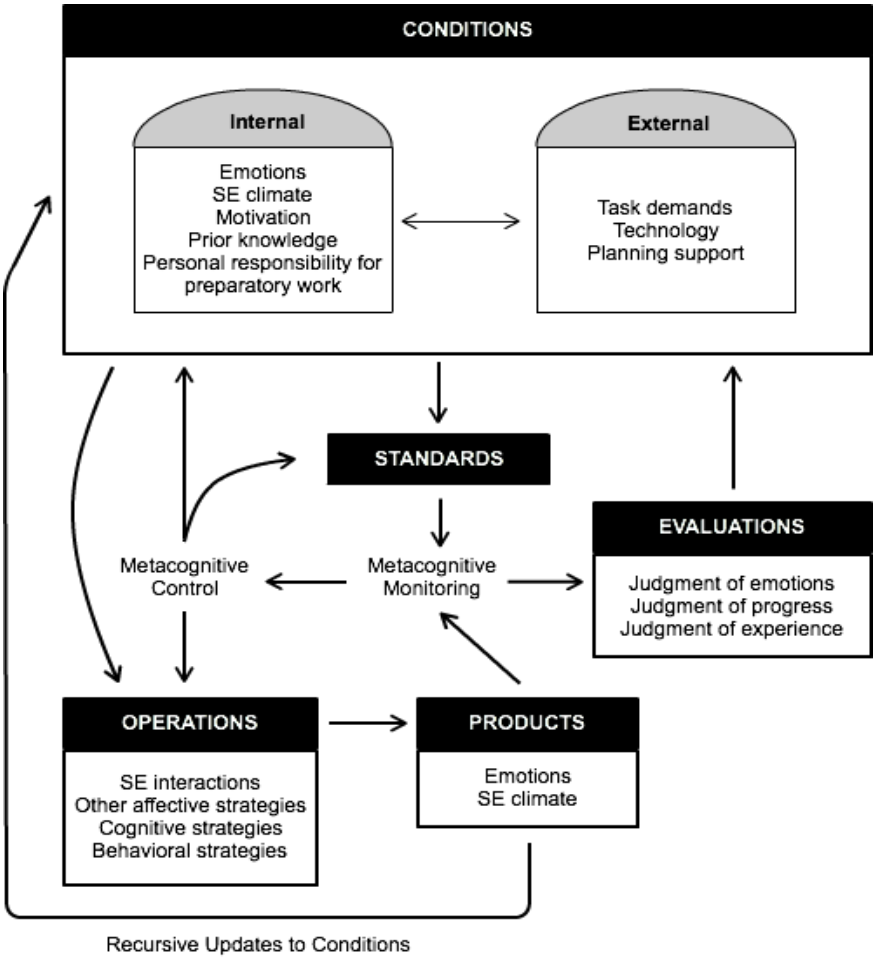

Fig. 1 Study constructs embedded within the COPES architecture. SE = socio-emotional.

Next, we further explain and distinguish three emotion constructs using the COPES typology: emotions, socio-emotional climate, and socio-emotional interactions.

Emotions as conditions and products. Emotions can be viewed as multi-componential entities made up of affective experiences or feelings, physiological responses, cognitive processes, behaviors or expressions, and/or action tendencies (Kleinginna and Kleinginna 1981; Scherer 2005; Solomon 2008). Although it is possible to distinguish among different affective constructs, such as mood and emotion (e.g., see Rosenberg 1998), we adopt a broader perspective in line with Boekaerts (2011) who indicates "the term 'emotion' is used in every-day language to refer to affectively charged cognitions, feelings, moods, affect, and well-being" (p.

412). Other researchers have also treated constructs such as mood and emotions more or less interchangeably (e.g., Koole 2009; Pekrun 2006).

From the perspective of the COPES model (Winne and Hadwin 1998, 2008), emotion is viewed as both an internal condition that frames how individuals or groups engage in regulatory processes as well as a product of that same engagement. For example, as a condition, one member's anxiety may lead to poor monitoring of group work, and that low quality monitoring may result in the products of greater anxiety and a sense of dissatisfaction. As the cycle continues, anxiety and dissatisfaction become conditions for subsequent engagement. As shown in the Conditions box in Figure 1, we acknowledge that the internal condition of emotions may interact with external conditions such as task demands, technology, and/or experimental conditions (e.g., level of planning support). We also emphasize that a regulation of learning perspective focuses on learners' *perceptions* of their emotions rather than the physiological responses, of which learners' may or may not have metacognitive awareness. To reiterate, regulation of learning is fueled by metacognitive monitoring—without awareness of one's current and desired states, purposeful regulation will not occur. For instance, recognizing that anxiety adversely influences the quality of work enables the learner to deliberately select and experiment with strategies for decreasing that emotion.

Socio-emotional climate as a condition and product. The socio-emotional climate of a group is determined by the behaviors of and interactions among group members, such as when group members demonstrate reliability and support and encourage each other (e.g., Janssen at al. 2010; Kwon et al. 2014). The range of emotions experienced within a collaborative setting, collectively, can contribute to group socio-emotional climate (Järvenoja and Järvelä 2009; Järvenoja and Järvelä 2013; Volet and Mansfield 2006). However, group members' emotional

states (individually or collectively) are not synonymous with socio-emotional climate, but rather may influence the behaviors and interactions that determine perceptions of climate. The differences between emotions and climate can be viewed as analogous to the weather system, where emotions occur as events (e.g., rain or shine) and socio-emotional climate is the persistent pattern of shared emotions and behaviors over a longer period of time (e.g., temperate moist coastal climate). The relation between emotions and socio-emotional climate is likely reciprocal, with emotional reactions enriching the description of a climate and vice versa. For instance, when a group member perceives a positive climate of trust and support in his group, this may produce affective responses such as increased confidence and decreased anxiety. These responses may then promote further positive socio-emotional interactions, helping to maintain the positive climate.

In Winne and Hadwin's (1998, 2008) COPES framework, we view socio-emotional climate as a product impacted by incoming conditions and operations, subsequently becoming a condition for further regulatory processes. During collaboration, socio-emotional climate may be monitored and evaluated by group members, which may result in individual members or the group as a whole enacting strategies to create or maintain a positive working climate. Socio-emotional climate, thus, fits into the model the same way emotions do; however, we view climate as less malleable and more persistent because it involves aggregation over events and people, rather than being a situational, in-the-moment response like emotions.

Socio-emotional interactions as operations. Unlike the perceptions that comprise emotions or socio-emotional climate described above, socio-emotional interactions refer to the purposeful interchanges (often communication) among group members that shape perceptions of emotions and socio-emotional climate, such as developing trust and cohesion, providing and

seeking support, and building confidence and motivation (Kempler and Linnenbrink 2006; Kreijns et al. 2003; Marks et al. 2001). Ideally, socio-emotional interactions between and among group members are positive in character, encouraging harmonious group functioning and positive emotions during group work. However, it is possible for socio-emotional interactions to undermine group functioning, particularly when negative socio-emotional interactions persist (Rogat and Linnenbrink-Garcia 2011) or when students do not possess appropriate skills to navigate group work (Järvenoja and Järvelä 2009). Prior research demonstrates socio-emotional interactions are interconnected with other regulatory processes and play a role in regulation of emotions. For example, positive socio-emotional interactions have been linked to higher quality and facilitative forms of social regulation (Rogat and Adams-Wiggins 2015; Rogat and Linnenbrink-Garcia 2011), co-regulatory acts that activate discussion and metacognitive acts of evaluation (Lajoie et al. 2015), and conflict resolution and improvement in emotions and motivation (Ayoko et al. 2012; Linnenbrink-Garcia et al. 2011; Näykki et al. 2014). In contrast, negative socio-emotional interactions have been connected to less effective and more directive forms of social regulation (Rogat and Adams-Wiggins 2015; Rogat and Linnenbrink-Garcia 2011) as well as negative emotions and lowered motivation (Näykki et al. 2014).

When situated in the COPES architecture (Winne and Hadwin 1998, 2008), we posit socio-emotional interactions can be viewed as manifestations of operations, being influenced by internal and external conditions and contributing to the affective products of group members' emotions and socio-emotional climate. Thus, the regulation of emotional aspects of group work includes taking control of methods of communication that can induce or mollify positive or negative emotions, ultimately contributing to the group's productivity and socio-emotional atmosphere (Järvenoja and Järvelä 2013; Kreijns et al. 2003). Note that both internal conditions

and products include group members' individual and collective emotions as well as the emerging socio-emotional climate. As conditions and products, emotions and socio-emotional climate both influence and result from the operations of socio-emotional interactions. Indeed, it is likely the three constructs—emotions, socio-emotional climate, and socio-emotional interactions—continually interact with one another throughout a collaborative session, such as when frustration is provoked by a persistent negative atmosphere, calling the group to regulate that emotion by changing the tone of their interactions.

Section summary. In essence, the dynamic and multidimensional activities that occur in collaboration imply emotion regulation in such contexts should occur at both the individual and group level to ultimately create and maintain a positive group climate necessary for productive collaboration (Järvenoja and Järvelä 2009). More specifically, groups employ different modes of regulation where they (a) self-regulate their own emotional states, (b) co-regulate fellow group members to regulate their emotional states, and (c) socially share in the regulation of the group's emotional states (Hadwin et al. 2011). Research examining emotion regulation in collaboration is limited, but empirical evidence provides support for the use of both individual and group-level regulation to overcome socio-emotional challenges and maintain positive group functioning (e.g., Ayoko et al. 2012; Järvenoja and Järvelä 2009; Näykki et al. 2014).

Purpose

Although research examining the affective dimension of collaboration is growing, limited research examines the regulatory behaviors and actions that contribute to or are influenced by a positive or negative socio-emotional climate, particularly in the context of computer-supported collaborative learning (CSCL; Dillenbourg et al. 2009; Järvelä et al. 2015). Not only might CSCL environments present different emotion-eliciting challenges than face-to-face

environments, but the expression and regulation of emotions might also differ, particularly when group members are limited to chat-based communication where traditional non-verbal cues (e.g., facial expressions) are absent. In a review, Derks et al. (2008) found evidence to indicate intense negative emotions were expressed more frequently in online interactions than in face-to-face interactions, which the authors propose may be due to being unaware of the impact of one's negative emotional reactions on other participants. The finding suggests there may be a need for more or different types of regulatory actions to encourage harmonious group functioning during online collaboration. Although emotion regulation was not a focus of their review, Derks et al. posit emotions can be more easily regulated in online communications because (a) typing a message provides time to monitor and control one's emotional expression and (b) participants do not observe each other's non-verbal emotional expressions. We agree that chat-based interactions may facilitate self-control over one's emotional expressions, but it may also be the case that a lack of traditional non-verbal cues may impede co- and shared regulation of emotions because of the difficulty in noticing others' emotions. To our knowledge, research examining socio-emotional processes in the context of regulation has mainly relied on observations of these processes during video-taped face-to-face collaborative sessions (e.g., Lajoie et al. 2015; Näykki et al. 2014; Rogat and Adams-Wiggins 2015; Rogat and Linnenbrink-Garcia 2011), although investigations within online settings are beginning to emerge (e.g., Janssen et al. 2010; Kwon et al. 2014).

This study provides two important extensions to prior research. First, we performed an in-depth analysis of two contrasting groups' socio-emotional regulation embedded within their broader regulatory behaviors, triangulating our interpretations (see Pitman and Maxwell 1992) by drawing on two data channels: (a) observed regulatory processes (i.e., planning, enacting,

adapting, and monitoring), regulatory modes (i.e., SRL, CoRL, and SSRL), and socio-emotional interactions during online collaboration and (b) data about emotional beliefs and perceptions gathered through self-reports before, during, and after collaboration. Second, unlike past research, we drew heavily from Winne and Hadwin's (1998, 2008) model of SRL and current conceptualizations of self-, co-, and shared regulation (Hadwin et al. 2011; Järvelä and Hadwin 2013; Miller and Hadwin 2015a; Winne et al. 2013) to guide our investigation. Towards this end, our analysis acknowledged the possibility that regulation of emotions occurs at individual and group levels.

The purpose of this exploratory case study was to examine the regulation of socio-emotional aspects of collaboration demonstrated by two groups with contrasting socio-emotional climates (positive vs. negative). Three research questions guided the inquiry: (a) with what set of conditions did each group enter the collaborative task, (b) how did the observed regulatory processes, regulatory modes, and socio-emotional interactions fluctuate and interact in each group, and (c) what were group members' perceptions of the collaborative experience in terms of their emotional reactions? To answer these questions, we conducted a qualitative cross-case analysis of two groups of undergraduate students collaborating on an online case-analysis assignment. More specifically, we adopted Braun and Clarke's (2006) thematic analysis methods to draw dominant distinguishing features between the positive and negative climate group.

Methods

Instructional Context

The broader context of this case study was a semester-long undergraduate course about learning processes and strategies for academic success. The purpose of this course was to equip students with the skills to engage in strategic, reflective, and adaptive individual and

collaborative learning. Among other graded and non-graded assignments, where students individually applied research from the learning sciences into their own studying, the course included two online collaborative assignments. The collaborative assignments together accounted for 30% of the final course grade and were introduced once in the middle and once towards the end of the semester. Given the exploratory nature of this study, only the first assignment data were analyzed.

The assignment included macro and micro scripts to help students navigate the collaborative process. At the macro level, students were guided through three broad phases of collaboration including (a) solo and group planning and preparation, (b) task enactment of a collaborative case analysis task, and (c) reflecting in order to adapt in future collaborative work. Each phase contained one or more supporting micro scripts. Figure 2 shows the specific macro-script steps guiding groups through the collaborative learning cycle. In Step 1 (Group Coordinated Individual Expertise), groups met briefly in an online chat room and were given a chance to familiarize themselves with the chat environment. Here, groups decided who would become the "expert" for each of four assignment topics: task understanding, goal setting and monitoring, self-regulated learning, and memory and learning processes. Each member was then responsible for preparing a one-page summary sheet related to his or her topic to be used as a reference tool during the collaborative case analysis task. Collectively, groups had a summary sheet for each major course topic necessary to solve the case.

In Step 2 (Solo Planning), group members completed a solo planning tool that guided and recorded their individual perceptions about the learning objectives of the task, personal goals, and plans they might share with their group before jumping into the collaborative case analysis task. In Step 3 (Group Planning), groups completed a planning tool guiding them to discuss and

jointly respond to questions similar to those in the solo planning tool. Both solo and group planning tools were an online form pre-stocked with similar questions and prompts. However, the framing of questions tapping into learners' perceptions of the learning objectives (i.e., what are you being asked to do and why) varied depending on the level of support provided to the group. Specifically, groups were assigned to one of four planning support conditions: (a) high-solo and high-group; (b) low-solo and high-group; (c) high-solo and low-group; and (d) low-solo and low-group. The high planning support contained pre-stocked selections of potential answers, whereas the low planning support contained open-text fields. During group planning, access to a collective summary of individual solo planning tool responses was provided.

Step 4 (Collaborative Case Analysis Task) consisted of a timed collaborative case analysis task that involved analyzing a 1-page case scenario about a fictitious student's learning behaviors. More specifically, groups were required to (a) analyze the student's strengths and weaknesses using the group's knowledge of theories and research in learning sciences introduced in the course, (b) identify and explain the root cause of the student's behaviors, and (c) recommend and justify strategies the student could use to improve learning. Group answers were recorded in a wiki page viewable by all group members but editable by only one member at a time. Groups completed the group planning tool and the collaborative case analysis task (Steps 3 and 4) during the same in-class 90-minute online session, where discussions were held in the same online chat environment introduced at Step 1. Specific for this timed session, each student was required to sign in to a computer located in one of the university's computer laboratories, supervised by at least one course instructor. Computer stations were randomly assigned to students. Students accessed the text-based chat tool, shared wiki, and case scenario in different windows on their computer. No face-to-face conversations occurred during collaboration.

Finally, in Step 5 (Solo Reflection), group members individually completed a solo reflection tool in which they reflected on the collaborative experience. Solo activities (Steps 1, 2, and 5) were individually completed outside of class time, but students were required to submit these activities before instructor-assigned deadlines.

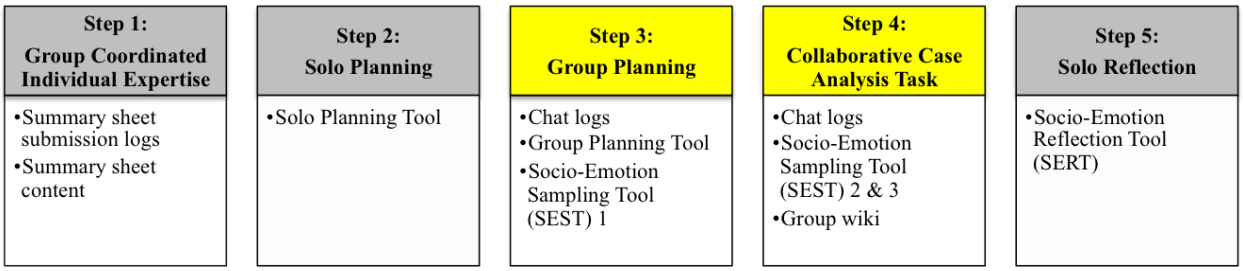

Fig. 2 Steps for collaboration in the first assignment are shown along with a list of data sources for each step. Yellow boxes indicate these steps took place in a timed online session.

All tasks in the collaborative assignment were delivered and completed via Moodle 2.4—learning management software familiar to students at the university. Students (N = 192 consenting students) worked in groups of three to five (48 groups in total) assigned by the course instructors. Course instructors did their best to make groups heterogeneous on the basis of gender, English as first language status, and prior knowledge as indicated by performance on the first course quiz. Because groups were assigned and students came from a wide array of programs and departments, group members were likely unfamiliar with each other personally beyond the course.

Data Sources

Figure 3 maps each data source onto the same COPES diagram presented earlier (see Figure 1). Following this, we describe the data sources used to measure each construct.

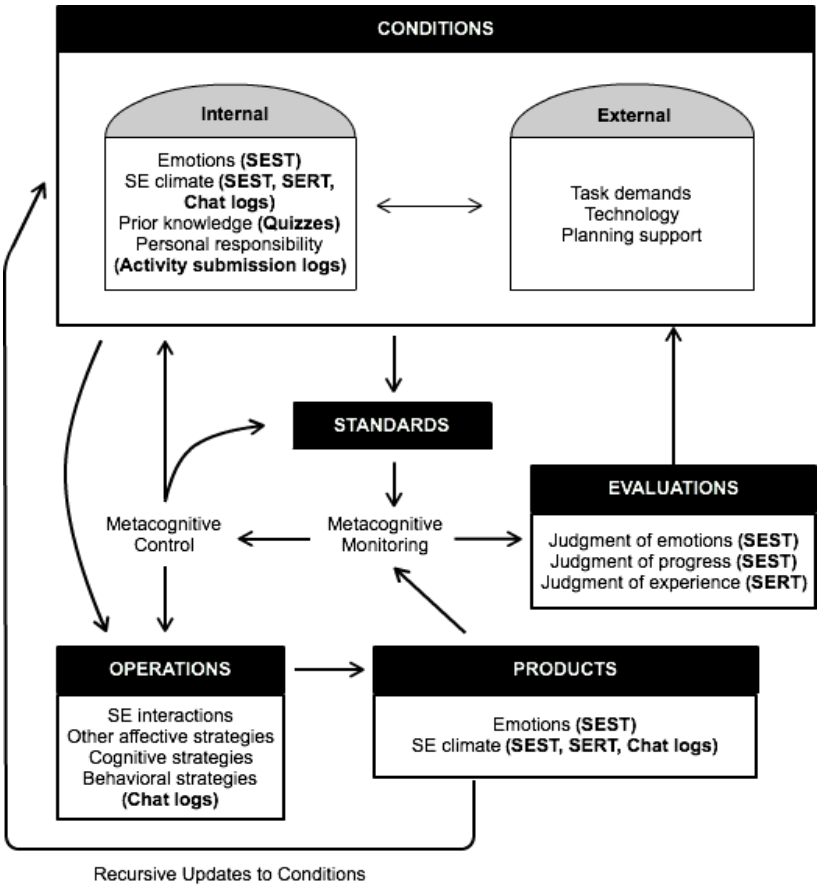

Fig. 3 Study constructs and data sources embedded within the COPES architecture. Data sources are listed in parentheses following the construct(s) they measure. SE = Socio-emotional; SEST = Socio-Emotional Sampling Tool; SERT = Socio-Emotional Reflection Tool.

Prior knowledge. This construct was measured by examining individual performance on three course content quizzes prior to collaboration (M_1= 70.0, SD_1=16.3; M_2= 78.4, SD_2=13.3, M_3= 69.6, SD_3=14.5), testing knowledge of four major topics covered in the collaborative assignment. Quizzes were developed and reviewed by a group of experienced course instructors and researchers in the area of regulation who ensured content validity of each quiz with respect to specific course topics and three levels of processing (understanding, connecting, and extending). Each quiz contained 10 multiple-choice questions and was counted toward students' final grade. Cronbach's alpha coefficient based on the 30 quiz questions was .49.

Personal responsibility. A global judgment of personal responsibility demonstrated by individual group members prior to the task was developed by reviewing records of when group members submitted their summary sheet and solo planning tool (Steps 1 and 2 in Figure 2) along with the content of those activities.

Emotions. The Socio-Emotional Sampling Tool (SEST) provided information about individual group members' (a) current emotional states and plans for regulating those emotional states (internal conditions and products), (b) judgments of their emotional states (evaluations), and (c) satisfaction with the group's progress (evaluations). Group members individually completed the SEST at the beginning, middle, and end of the in-class collaborative session (Steps 3 and 4 in Figure 2). The SEST facilitated the construction of a self-narrative about students' salient emotion in the moment with respect to collaboration. Rather than including a set of isolated questions, the SEST was designed with drop-down menus embedded in first-person sentences, enabling students to quickly create a cohesive narrative of their current emotional state (see Figure 4).

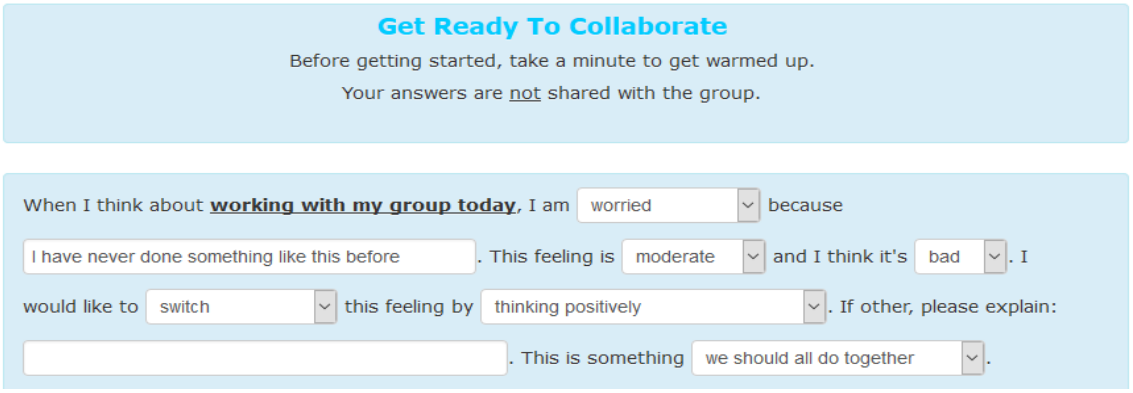

Fig. 4 Sample items from the Socio-Emotional Sampling Tool (SEST)

In particular, students indicated (a) a salient emotion they were experiencing related to working with their group from a drop-down list, (b) the source of their emotion in an open-text

field, (c) the intensity of their emotion (from *very weak* to *very strong*), (d) whether their emotion was good or bad, I a goal for regulating their emotion (increase, decrease, switch, maintain, do nothing about), (f) a strategy they intended to use to regulate their emotion from a drop-down list, and finally, (g) if the strategy should be enacted individually or as a group. In the midpoint and final SEST, students also reported their level of satisfaction with progress (from *not very* to *extremely* satisfied). The drop-down list of emotions included six positive emotions (excited, optimistic, confident, happy, focused, calm) and six negative emotions (anxious, worried, stressed, doubtful, frustrated/angry, disappointed). There is little prior research on the specific emotions students experience during collaboration. These 12 emotions were chosen because they represented a balance of positive and negative emotions, were among frequently reported emotions in other data we have collected from students about their emotions during independent studying, and were relevant for a collaborative context. The drop-down list of strategies included eight strategies: creating a good plan, changing the plan or approach, focusing on the task, changing thoughts or beliefs, thinking positively, talking to others in the group, taking deep breaths and/or relaxing, accepting it and carrying on. This list was developed from existing theory and research in both individual and collaborative contexts (Gross 1998; Järvenoja and Järvelä 2009; Schutz et al. 2004; Webster and Hadwin 2014). Students also had the option to "do nothing about" their emotion or indicate they would do something else not on the list. The aim in developing the drop-down list was to include a limited number of strategies for students to choose from that met the following three criteria: (a) the strategies were appropriate for the context; (b) the strategies were specific enough to be useful, but also adaptable to the student's particular situation; and (c) the list covered the major types of strategies identified in theory and research.

Individual perceptions of socio-emotional climate. Two measures provided information about group members' perceptions of the socio-emotional climate: (a) the midpoint and final SEST (described previously) contained one item assessing perceptions of the atmosphere (positive, negative, or neutral) and (b) the Socio-Emotional Reflection Tool (SERT) contained two items targeting perceptions of the collaborative experience. Preliminary examination of SEST data of the full sample of groups showed that very few students (3.1%) reported a negative atmosphere. This may be indicative of an unwillingness to report a problem in the group *during* the collaboration. The SERT was completed as part of the solo reflection tool (Step 5 in Figure 2). By prompting students to reflect on a positive or negative experience that occurred during the in-class collaborative session, the SERT aimed to build awareness of successes or difficulties so students could more effectively plan and prepare for future collaborative situations. Students were first asked to describe a salient experience in an open text field and then select from a drop-down menu whether the experience was positive or negative. This information was used as the first data point for selecting cases for analysis as described in the next section.

Socio-emotional interactions and observed socio-emotional climate. Chat logs provided evidence of outward instantiations of socio-emotional interactions and informed our perceptions of the socio-emotional climate as a product and a condition. ZohoChat—a synchronous text-based chat tool that contains a running record of all chat history and allows students to enter the chat where it was left off—was used to host and record collaborative discussions during the timed online session.

Regulatory processes and modes. The chat logs described above were used to examine groups' regulatory processes (planning, enacting, adapting, monitoring) and regulatory modes

(SRL, CoRL, SSRL) used to carry out the processes. Processes and modes occur at the macro level, where they can be aimed at taking control of cognition, behavior, motivation, and/or emotions.

Case Sampling Strategy and Case Descriptions

Extreme case sampling (Miles et al. 2013) was used to identify two maximally contrasting groups in terms of the overall socio-emotional climate during collaboration. We intentionally blinded ourselves to the planning support condition assigned to each group because we did not want the condition to bias our perceptions of the groups' socio-emotional climate. Judgments of socio-emotional climate were drawn from three main data sources: (a) rating of a salient affective event as positive or negative (SERT), (b) text based descriptions of a salient affective event that was positive or negative (SERT), and (c) overall positive or negative tone of the group chat discussion reflected in field notes recorded by two independent researchers (chat logs). Based on ratings of a salient affective event in the SERT, cases were narrowed down to six potential cases wherein (a) all four group members reported a salient affective event they rated as positive (four groups in total) or (b) all four group members reported a salient affective event they rated as negative (two groups in total) after collaboration. For all six groups, we confirmed that the affective event described in an open text field by each individual was consistent with that person's rating of the event as positive or negative. This collection of responses was used as an indicator of the group's global judgment of the overall socio-emotional climate of the group. Importantly, these reflection data were used as a starting point to select our cases because retrospective reports reveal emotional perceptions or beliefs that are products of collaboration and likely serve as a condition informing future collaboration. It is possible during a collaborative task students experience a range of emotionally charged events, but the emotional

memory that stands out for them—as reported in their reflections—is an important condition for future collaboration.

Finally, chat logs for each of the six groups were independently reviewed by two researchers tasked with documenting holistic impressions and observations in open field notes. Field notes particularly attended to overall tone and climate. Field notes were used to choose one of the four groups reporting a positive affective event and one of the two groups reporting a negative affective event. The two groups chosen represented maximal variation in the overall holistic impressions of tone and climate recorded in field notes. Herewith, we refer to one group as the positive climate group and the other as the negative climate group.

The positive climate group was consistent throughout their open-ended descriptions in the SERT describing a positive and supportive group that worked well together. Field notes about chat discussions corresponded with individual reports, noting polite and respectful exchanges and deliberations throughout the task. In contrast, the negative climate group reported running out of time as a salient negative event during collaboration. One member also noted the group did not know how to collaborate, suggesting the group struggled to function productively. Field notes about chat discussions noted multiple points of frustrations and tensions negotiating roles and contributions. Table 1 summarizes demographic information of the individuals comprising each group. All students were in their first semester of university. Hence, it is likely these students had little, if any, previous experience with university-level collaborative work at the point of data collection.

Table 1 Summary of participants' demographic information

	Positive climate group	Negative climate group
Group members	Tom *(male; non-ESL)* Jessica *(female; non-ESL)* Angie *(female; non-ESL)* Suparna *(female; ESL)*	Jay *(male; non-ESL)* Steve *(male; ESL status not reported)* Seiko *(female; ESL)* Jing *(female; ESL)*
Mean age (years)	17.8	18.0

Note. All names used in examples are pseudonyms. ESL = English as a second language.

Chat Transcript Coding

Chat transcripts were coded on three dimensions: (a) regulatory processes, (b) modes of regulation, and (c) socio-emotional interactions. Drawing from Barbour (2001), we acknowledge that in the context of an in-depth cross-case analysis where complex processes and interactions are coded by two researchers, "concordance between researchers is not really important; what is ultimately of value is the content of disagreements and the insights that discussion can provide for refining coding frames. The greatest potential of multiple coding lies in its capacity to furnish alternative interpretations... Such exercises encourage thoroughness, both in interrogating the data at hand and in providing an account of how an analysis was developed" (p. 1116). With this in mind, we conducted multiple reviews of both the coding scheme and the coded data and engaged in discussions with other knowledgeable researchers in the field to reveal alternative interpretations and insights. Coding for each dimension progressed in a similar manner. First, an initial coding scheme was developed from existing theory and research. Second, the coding scheme was applied to the data by independent coders including the first two authors. The team then reconvened to discuss and revise the coding scheme to better reflect the data. Rather than dividing the chat into episodes and coding at the episode level, each utterance in the chat was coded. An utterance could expand across multiple chat lines by the same student as long as all lines pertained to the same thought. This second step was repeated until code descriptions were

agreed upon. The second author then applied the final coding schemes to all chat data. Initial Krippendorff's alpha between the first two authors for 20% of the data was .67 for regulatory processes, .62 for modes of regulation, and .69 for socio-emotional interaction codes. Finally, all codes were reviewed by the first two authors, who discussed any disagreements until a consensus was reached.

Regulatory processes. Table 2 presents the final version of the coding scheme for regulatory processes. Informed by an extended version of Winne and Hadwin's (1998) self-regulated learning model described by Miller and Hadwin (2015a), regulatory processes coded in this study included the acts of (a) planning, where learners construct task understanding and set goals, (b) enacting, where learners employ strategies for achieving task goals, and (c) adapting, where learners make changes in response to a perceived challenge. The authors not only describe how the three processes occur at an individual level but also take into account regulation that occurs at the social level. These regulatory processes—planning, enacting, adapting—can target cognition, behavior, motivation, emotions, or a combination of these facets of learning. In this study, coding of regulatory processes was not exclusive to emotion regulation; instead, we aimed to examine the emotional products and subsequent conditions that arise from engaging the regulatory processes (e.g., anxiety that follows ineffective planning and becomes a condition for task enactment).

In line with the SRL model, we included a code for metacognitive monitoring and evaluating, which fuel regulatory processes. On the basis of earlier iterations of coding, we also added orienting as a distinct subcode of monitoring, keeping it as a separate subcode because of its high occurrence. Orienting represents low-level coordinating statements where the main purpose is to situate the group member(s) in terms of the environment and task (e.g., monitoring

who is in the chat or what question is being worked on). Orienting differed from other forms of monitoring—such as monitoring progress—in its lack of connection to plans, goals, or standards. For example, establishing whether everyone is looking at the same question (coded as orienting) simply allows the group to move forward with their work, whereas stating the question needs to be completed in five minutes (coded as monitoring) is a form of monitoring progress against time standards.

Modes of regulation. The coding scheme for modes of regulation (Table 3) was informed by Hadwin and colleagues' (Miller and Hadwin 2015a; Hadwin et al. 2017) descriptions of self-regulated learning (SRL), co-regulated learning (CoRL), and socially-shared regulation of learning (SSRL). In addition to the three codes of SRL, CoRL, and SSRL, we included a code for co-regulatory requests where individuals requested support for their own regulation (Hadwin et al. 2017). The act of co-regulation (providing support) may or may not have occurred in response to these co-regulatory requests.

Because it is possible for regulatory processes to occur at individual and group levels simultaneously and for an individual to promptly switch from individual to group regulation within one speaking turn, codes for modes of regulation could overlap. For example, when a group member announced what he was individually working on (monitored his own progress) and asked for an update from his group (monitored his group's progress), this statement was coded as both SRL and CoRL. Furthermore, when a group member acted in response to co-regulatory support provided by another group member, the response was coded as both SRL and CoRL to indicate the transfer of regulation. The addition of this round of coding helped to decode the social nature of regulation, which includes the dynamic interplay between an

individual, others, and the group. For instance, a less supportive group may display fewer co-regulatory acts that are positive in nature.

Socio-emotional interactions. Outward instantiations of emotion regulation observed in the form of socio-emotional interactions were examined at this level. The coding scheme for socio-emotional interactions (Table 4) was informed by several pre-existing socio-emotional coding schemes in the literature (e.g., Ayoko et al. 2012; Lajoie et al. 2015; Linnenbrink-Garcia et al. 2011; Näykki et al. 2014; Rogat and Adams-Wiggins 2015; Rourke et al. 1999). Similar to modes of regulation, it was possible for turns to receive more than one socio-emotional code. In line with previous research, positive interactions included apologizing, humor or laughter, encouraging members' participation and motivation, and promoting trust and cohesion among group members. Negative interactions included discouraging participation and motivation, low cohesion (emphasizing the individual over the group), and pressuring others. Because text-based chats often involve the use of emoticons and symbols to express and emphasize emotions, we included a code for expressing emotions, which was also applied to the use of emotion language. We did not categorize expressing emotions as a positive or negative socio-emotional interaction because (a) regardless of what emotions are being expressed, the act of expression itself could be beneficial or detrimental to the discussion and (b) some symbols could be ambiguous with respect to what emotion the group member is intending to convey.

Table 2 Coding scheme for regulatory processes

Code	Description	Examples[a]
Planning	Defining task perceptions, setting goals, and making plans for cognitive, behavioral, and/or affective aspects of the task.	**Task perceptions** *Angie:* ok so it seems like in the first one the majority of us think that our task is to analyze the scenario, identify srl strengths and weaknesses, come up with a solution and back up our answers with examples **Making plans** *Jay:* So whos going to be the editor? Shoty not *Steve*: I would prefer not to *Jay*: I only want to opt out because I am not a super fast typer
Enacting	Indicator of strategy use. Purposefully adopting and adapting tools and strategies to attain goals and standards and mediate challenges. Also includes stating domain-related knowledge or content for the task product.	**Strategies for thinking / understanding** *Jay [making use of distributed expertise]:* Im having trouble seeing [domain concepts]... Seiko, this is your specialty. What do you think? **Strategies for behavior / task / team engagement** *Tom:* easily fixable for you Angie, just some cut and pasting *Jing [after realizing they are running out of time]:* don't spend too much time on the plan, we need to focus mainly on the challenge part, haha **Domain / content contribution** *Jing:* Brian does not pay attention in class, because he thinks that reading the textbook will get him good marks in the exam. He does not understand the connections between the concepts and the teacher's examples.

Monitoring and/or evaluating	Monitoring and/or evaluating task understanding, progress, and products in relation to behavioral, cognitive, or affective goals and standards.	**Task perceptions / plans** *Tom:* I didn't know we had to study the diagrams for this *Suparna [evaluating the correctness of the plan]:* Yeah thats what I was thinking too / everyone agree? *Angie:* yes me too **Task product or progress** *Jay [when not getting much response from group members]:* more contributions? *Suparna:* lol I just saw it before I came *Tom:* I think you got it Suparna
Orienting (subcode of monitoring)	Situating or positioning self or others in terms of the group, environment, and task. Low-level coordinating statements / announcements where the main purpose is to situate or move things along.	*Jay [while members are logging on to the chat]:* hey guys, are we all in the chat? *Angie:* Ok should we look at the group summery now then?
Adapting	Making a purposeful change to task perceptions, goals, plans, or behavioral / cognitive / affective strategies to overcome a challenge in the current task or in future tasks. Always a secondary code in relation to what the change is about. Often preceded by monitoring.	*Tom:* so I think only one person can edit at a time. *Angie:* yes / Samir copy and paste wht you wrote into chat and I will put it in? *Jay:* were really running out of time!! *Jing:* who is responsible for B / let's divide the last things

Off-task	Off-task statements and social greetings.	*Jing:* hello! *Seiko:* Who typed all caps hahaha
Uncodable	Partial statements and/or statements where the meaning is not clear.	

[a]Chat excerpts have not been corrected for grammatical errors, formatting, etc.

Table 3 Coding scheme for modes of regulation

Code	Description	Examples
Self-regulation	Individual deliberately plans, monitors, and/or regulates their own cognitions, behaviors, motivation, and emotions in the joint task.	*Seiko:* I am working on my answers. I will post them when I check it. *Seiko:* Still working on it. For strength, I have this so far.
Co-regulation	Individual or group supports or influences one or multiple members' individual regulation processes or the group's shared regulation processes. These regulatory processes can target cognitions, behaviors, motivation, and/or emotions. Co-regulation creates affordances and constraints for productive self-regulated learning and/or shared regulation of learning.	*Angie:* Sorry guys where are we here? *Tom:* Number 6 *Jessica:* Its #2 in the personal part but in the thing you're filling out it is Number#6. I think. *Angie:* oh right sorry yes I'm doing #6 too.
Co-regulatory request	Individual requests support for regulation.	*Angie:* Sorry guys where are we here? *[This is a request to the above co-regulation example]*

Socially-shared regulation	Group members collectively negotiate and realign or adapt group regulation processes targeting cognition, behavior, motivation and/or emotions. Shared regulation is transactive in that multiple individual perspectives contribute to the joint effort to take control of the task.	*Angie:* ok so it seems like in the first one the majority of us think that our task is to analyze the scenario, identify srl strengths and weaknesses, come up with a solution and back up our answers with examples. *Angie:* Does that sound about right? *Jessica:* I agree *Suparna:* Yeahh. They all have more than 75 % *Tom:* Agreed

Table 4 Coding scheme for socio-emotional interactions

Code	Description	Examples
Positive interactions		
Apologizing	Apologizing to another member / the group in response to a perceived challenge (e.g., confusion, making a mistake, taking too long, etc.). Could be considered a strategy to promote positive emotional reactions or to reduce or avoid negative emotional reactions.	*Suparna:* I am almost done / sorry *Jing:* im sorry Jay should have told you earlier ☹
Humor / laughter	Using humor or laughter to potentially ease tension or create a positive atmosphere.	*Tom:* who's editing? Not me because I lost this debate haha
Encouraging participation / motivation	Encouraging or facilitating others' participation by seeking feedback or contributions, promoting openness, providing positive feedback, making a polite request or suggestion, or providing reassurance. Also includes motivational or enthusiastic statements.	**Seeking feedback** *Jessica:* I think that the root of his problem must be [domain contribution]. Do you agree? Then we can discuss how it impacted the rest? **Providing positive feedback** *Tom:* you did a great job with the planner

		Polite request *Jessica:* Samir, could you put what is complete into the page and save it so that we can read them more easily and then add anything we think is needed? **Providing reassurance** *Suparna:* I am almost done / sorry *Angie:* no worries **Enthusiasm** *Jing:* :D lets get started!
Promoting trust / cohesion	Promoting trust and cohesion by appealing to external factors (e.g., task or instructor directions) to potentially ease tensions or using "we" statements to imply the group is working together or should work together.	**Appealing to external factors** *Tom:* [instructor] says we should be starting our scenarios shortly **"We" statements** *Jessica:* thanks everyone i think we did a really good job
Negative interactions		
Discouraging participation / motivation	Discouraging participation and undermining task contributions by criticizing another's work, ignoring feedback or questions, or rejecting contributions. Also includes undermining one's own or the group's abilities (low efficacy) and avoiding commitment to the task.	**Undermining another's contribution** *Jay [after another member has submitted an answer]:* are we not supposed to use past tense? **Low efficacy / commitment** *Jay:* I only want to opt out [of being editor] because Im not a super fast typer

Low cohesion	Statements that imply the group is not working together or that emphasize the individual over the group. Includes taking personal credit for or emphasizing one's own ideas.	*Jay:* WE DON'T DISCUSS UNTIL WE HAVE ANSWERED EVERY QUESTION IN THE CHALLENGE, in my opinion?? That was what I intended when we wrote the plan of attack
Pressuring others	Telling another member / the group what to do without asking, suggesting, or being polite. Includes overruling interactions where the member makes a decision for the group or rushes the group to move on without seeking more input.	*Angie:* group plan 182sn't being graded lets move on! *Jay:* lets goo people / I need your answers>>?
Expressing emotions	Expressing emotions by using emoticons, emphasis (e.g., caps lock, ??), or emotion language / expressions.	**Emoticon** *Jay:* I can be editor I guess.... :/ **Emphasis** *Jay:* whos the last person in our group and where are they?? **Expression** *Jay:* our supervisor said we should be done!! Ahh

Analysis and Findings

Analytical Approach

Loosely guided by Braun and Clarke's (2006) thematic analysis, we primarily used a data-driven technique to generate important themes describing the differences between the positive and negative climate groups. We began by documenting general observations of each data source, collected from the beginning to the end of the collaborative assignment. Next, using inductive and deductive approaches, we constructed and refined the coding schemes for the observation data (i.e., chat logs). Upon completion of coding, we examined the fluctuation in codes over time and the convergence between and among categories of codes to generate potential themes. Using all data sources, we iteratively reviewed and defined emerging themes until we reached an agreement that the final list of themes best reflected the differences in the two cases.

Code fluctuations over time. To examine the fluctuation of each code over the course of the online collaborative session, we broke the session into equal time segments and calculated code frequencies occurring in each time segment (for total frequencies across the whole session, see Table 7 in the Appendix). For regulatory processes and modes (Figures 5 and 6), we broke the session into three 30-minute segments with a fourth time segment representing overtime (i.e., the time group members stayed beyond the original 90-minute time limit). For socio-emotional interactions (Figure 7), we broke the session into six 15-minute segments plus overtime. A smaller time interval was selected because socio-emotional interactions were more dynamic, with codes changing relatively quickly over fewer turns—a characteristic that was less apparent with a 30-minute time interval. Examining the fluctuation in code frequencies allowed us to look for patterns that differentiated the groups in terms of (a) how actively each group demonstrated

the various regulatory processes, regulatory modes, and socio-emotional interactions and (b) how their actions changed over the course of the session.

As this was an exploratory study, our main purpose was to pinpoint differences warranting further research. We focused on frequencies because groups were given the same amount of time (90 minutes) to work on the task. No count statistics were performed to determine statistically significant differences. Rather, we were primarily interested in examining the nature of code transitions over time, which is in line with our assumption that regulation is a recursive and adaptive process that unfolds across phases. For example, a typical pattern of transitions in a productively regulating group might include a higher prevalence of planning early in the task, a higher prevalence of enacting in the middle of the task, and a higher prevalence of monitoring towards the end of the task (Winne and Hadwin 1998; Zimmerman 1989). We would also expect to see a productive group concurrently engaging in SRL, CoRL, and SSRL, with the latter two modes more prominent as groups work toward a joint outcome (Hadwin et al. 2011). Finally, given that we view socio-emotional interactions as operations within regulatory cycles, we examined the fluctuation of socio-emotional interactions over time in relation to the emotional products of emotions and socio-emotional climate. For example, negative socio-emotional interactions that occur early and persist throughout the task would likely have a debilitating effect on groups' socio-emotional climate (e.g., Näykki et al. 2014).

Overlapping codes. To demonstrate the interplay between and among regulatory processes, regulatory modes, and socio-emotional interactions, we graphed the co-occurrences of these codes for each socio-emotional climate (Figure 8).

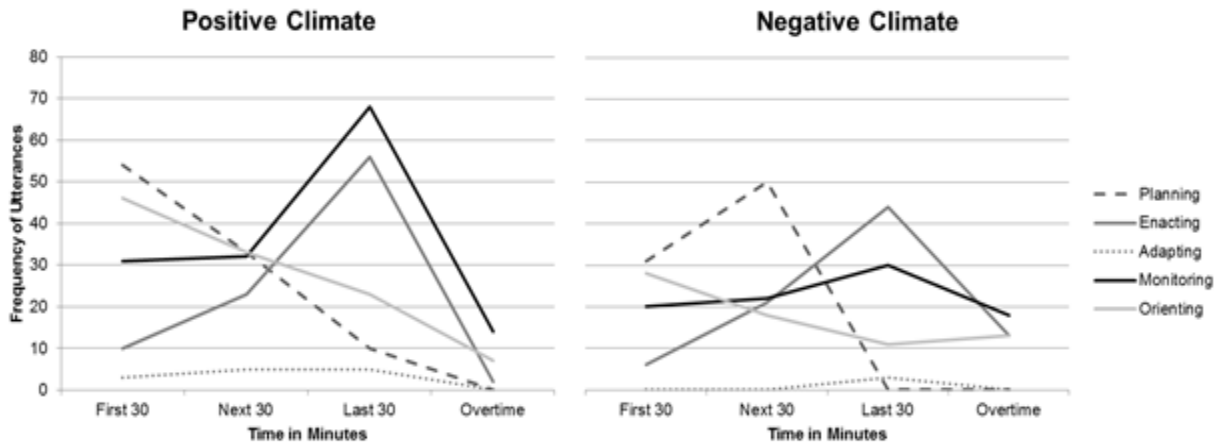

Fig. 5 Regulatory processes over time

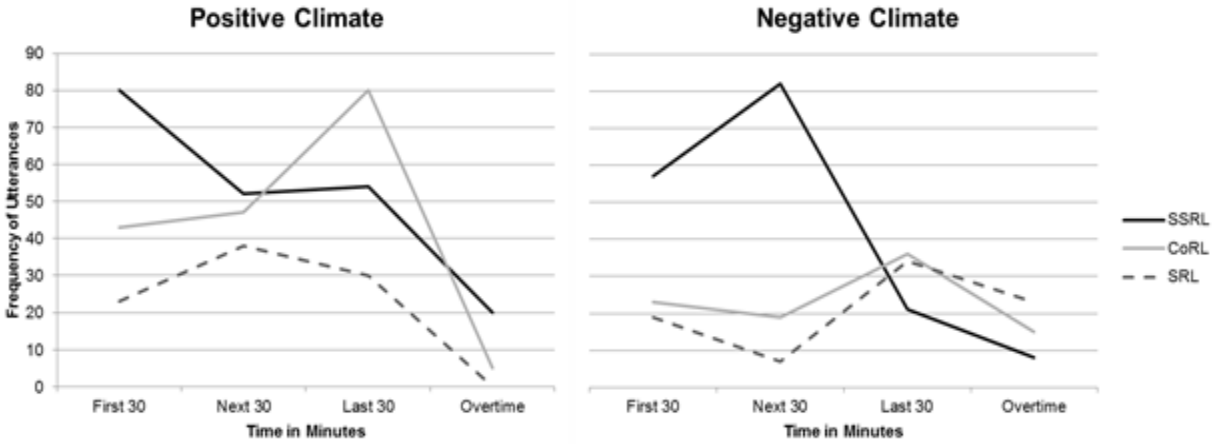

Fig. 6 Modes of regulation over time.

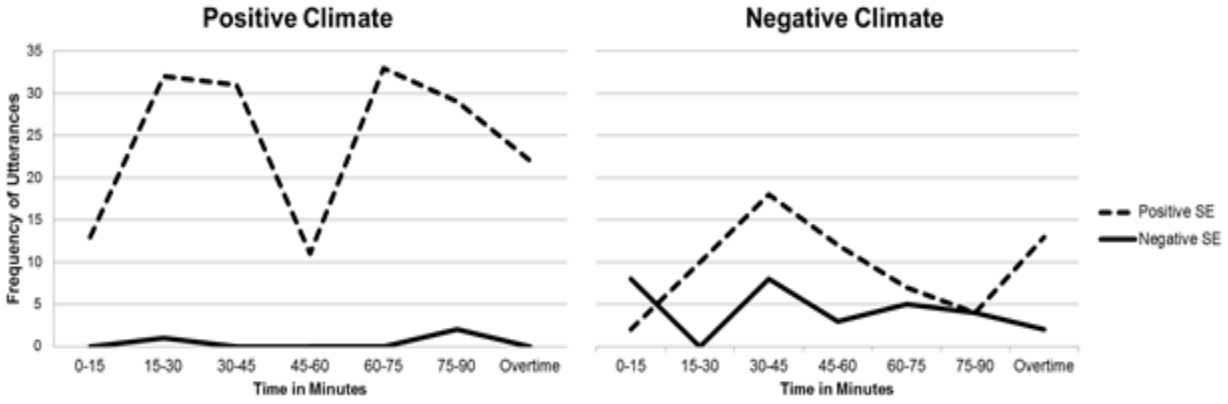

Fig. 7 Socio-emotional interactions over time

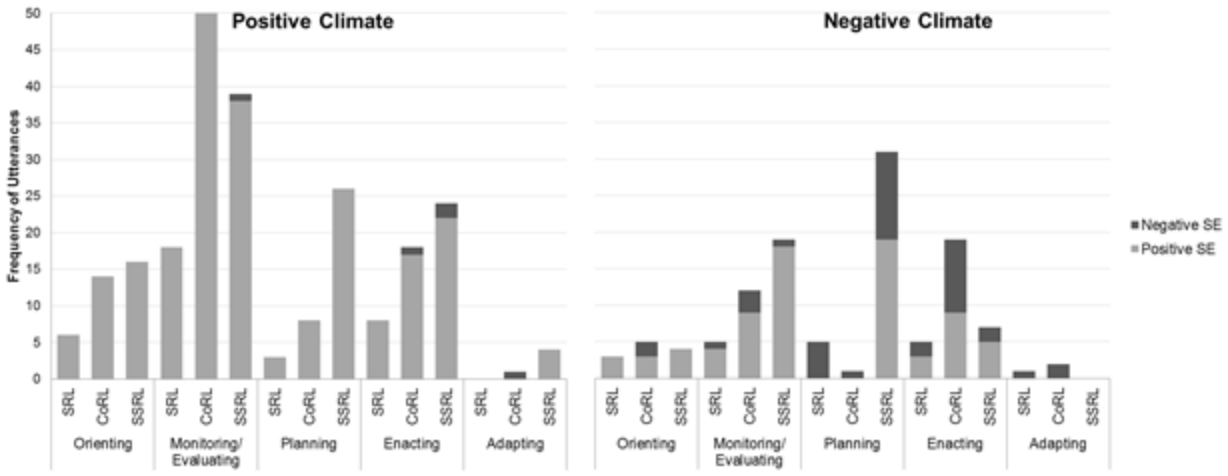

Fig. 8 The degree of overlap between socio-emotional interactions, regulatory processes, and regulatory modes in both groups expressed in frequency. SE=Socio-emotional interactions.

Overall, Figures 5 to 8 above demonstrate interesting interplay between regulatory processes, modes, and socio-emotional interactions. Informed by this pattern of interactions and corroborated by other data sources gathered at several points of the collaborative process, our analysis culminated in four broad themes that distinguished the two groups: (a) incoming conditions as a foundation for creating a positive collaborative experience, (b) regulation of emotions during initial planning, (c) negative emotions as a constraint for shared adaptation in the face of a challenge, and (d) encouragement and motivational statements as an effective strategy in sustaining a positive socio-emotional climate.

Theme 1: Incoming *Conditions* as a Foundation for Creating a Positive Collaborative Experience

In the COPES architecture of SRL (Winne and Hadwin 1998, 2008), incoming conditions are data upon which students base regulatory evaluations, judgments, and decisions in each phase of regulation. In our study, upon entering the collaborative online session, group members carried a set of conditions with the potential to influence their cognitions, behaviors, and affect for group planning and task enactment. Our examination of a subset of those conditions

(summarized in Table 5) suggests the following two factors may contribute to a positive collaborative experience: (a) overall better preparation in terms of prior knowledge of expertise topics and personal responsibility for submitting individual planning activities, likely influenced by differences in implicit guidance tools introduced at solo planning (Step 2, Figure 2) and (b) plans for shared regulation of emotions.

Table 5 Entering conditions for each group

Conditions	Positive climate	Negative climate
Prior knowledge		
Mean quiz scores for assignment topics	70.8%	68.3%
Range of prior knowledge	53.3% - 93.3%	56.7% - 80%
Preparation and personal responsibility		
Solo planner completed by deadline	3 students	3 students
Mean task understanding score for solo planner	62.5%	52.5%
Task understanding score for group planner	70.0%	80.0%
Summary sheet completed by deadline	4 students	2 students
Summary sheet contained adequate information	3 students	2 students
Responses on first SEST		
Positive emotion reported	1 student	3 students
Negative emotion reported	3 students	1 student
Plan to self-regulate emotion	1 student	4 students
Plan to regulate emotion together	3 students	0 students

Individual preparation. Individual preparation in the positive climate group differed from the negative climate group in three main ways. First, students in the positive climate group excluding Tom had better prior knowledge of course concepts related to their assigned expertise (summary sheet) topics as indicated by their individual course quiz grades (Table 6). Second, students in the positive climate group were better prepared in terms of submitting summary sheets on time and including adequate course concepts on the summary sheets. Taken together, these data suggest members of the positive climate group knew the topic they had taken

responsibility for and were in a good position to create a summary sheet with adequate information.

Table 6 Group members' expertise topics and quiz scores (%)

Group member	Expertise topic	Quiz 1	Quiz 2	Quiz 3	Mean
Positive climate					
Tom	SRL	**40.0**	60.0	60.0	53.3
Jessica	Task understanding	**90.0**	100.0	90.0	93.3
Suparna	Goal setting & monitoring	100.0	**80.0**	50.0	76.7
Angie	Memory & learning processes	50.0	50.0	**80.0**	60.0
Negative climate					
Jay	SRL	**70.0**	90.0	80.0	80.0
Seiko	Task understanding	**70.0**	70.0	80.0	73.3
Jing	Goal setting & monitoring	80.0	**50.0**	60.0	63.3
Steve	Memory & learning processes	50.0	70.0	**50.0**	56.7

Note. Bolded quiz scores indicate the quiz corresponding to the group member's expertise topic.

The third difference related to the level of individual planning support provided to each group. In particular, members of the positive climate group completed the highly guided individual planning tool containing questions with pre-stocked answer fields, whereas members of the negative climate group completed the loosely guided individual planning tool containing questions with open-ended answer fields. There was no difference between groups with respect to the level of support for group planning, with both groups receiving the highly guided group planning tool. Previous research using similar sets of tools revealed that, regardless of the level of individual support, a high level of group support was associated with more accurate group task perceptions (Miller and Hadwin 2015b). Consistent with this finding, the positive and negative climate groups were similar in their group-level task perception scores (70% for the positive climate versus 80% for the negative climate; M = 63.3%, SD = 20.5). However, the high level of individual guidance provided to members of the positive climate group at solo planning seemed

to improve the accuracy of their individual task perceptions as indicated by the range of scores in the group (mode of 70%). Having mostly high task understanding may have contributed to better preparation and higher levels of confidence in the positive climate group members' ability to perform the task. In contrast, although the negative climate group had a comparable average individual task perception score (M = 52.5% vs. M = 62.5%), the range of scores in this group was rather large, with two members scoring very low (10% and 20%) and two members scoring very high (80% and 100%). The two low-scoring members were the same individuals that submitted late summary sheets with relatively inadequate information, suggesting these two group members may have been less motivated or engaged prior to collaborating.

Emotions and planned strategies prior to collaboration. The groups also differed with respect to their SEST responses at the beginning of the online collaborative session (see Table 5). Of note was the contrast in emotions and planned mode of regulating those emotions. Emotions reported by the positive climate group prior to collaboration were predominantly negative (3 of 4 members), originating from group members' concerns regarding how well the group would work together, whereas emotions reported by the negative climate group prior to collaboration were predominantly positive (3 of 4 members), reflecting perceptions of confidence and being individually prepared for the collaborative task. It is possible that experiencing negative emotions prior to collaboration with a new group set the stage for a different approach to planning for collaboration in the positive climate group. Data indicated the positive climate group planned to share responsibility for regulating emotions with their group, reporting "this is something we should all do together." In contrast, the negative climate group planned for a more individual approach for regulating emotions, with two members indicating "this is something I should do" and two members indicating "this is something each of us should do." Perhaps

influenced by this individual approach, the group may have paid less attention to the nature of their interactions, ultimately creating the observed negative socio-emotional climate. Of particular note, one group member (Jay) who was dominant in setting the observed negative tone appeared to be working toward the goal of maintaining his own focus on the task. Focusing on an individual goal may have come at the expense of creating a positive working environment.

Summary. Taken together, data gathered about groups' incoming conditions point to two important factors for establishing a positive socio-emotional climate. First, engaging in adequate preparation or self-regulation prior to the task helps set the stage for a positive collaborative experience. Second, planning to share the responsibility of regulating emotions may be necessary for the group to successfully manage any negative emotions that might be harmful to the group's productivity during collaboration. Accordingly, the positive climate group was observed regulating productively and interacting positively (described in the next section) despite perceiving negative feelings at the beginning of the task. On the other hand, when group members are less prepared and focused more on individual regulation during collaboration, they may be less successful in regulating the emotional aspects of collaboration, resulting in negative emotions that persist throughout the task, as demonstrated in the next section.

Theme 2: Regulation of Emotions (*Operations*) During Initial Planning

In line with research conducted by Fransen et al. (2011), initial group affect set the stage for more complex collaborative processes, such as building shared task perceptions, to take form. Within initial stages of collaboration, it is important for group members to build trusting relationships as a foundation for effective group functioning. According to Van den Bossche at al. (2006), interpersonal trust is built when team members believe the group is ready to interdependently exist and each member has confidence the group can succeed (see also

Williams 2007). Our analysis of the initial stages of collaboration indicated the positive and negative climate groups differed with respect to (a) productivity and conflict during initial planning and (b) valence of emotions experienced after initial planning.

Interactions during initial planning. Our examination of code fluctuations revealed that, in the first 15 minutes (initial planning phase), positive interactions dominated the positive climate group's discussion, whereas negative interactions dominated the negative climate group's discussion (see Figure 7). The initial planning session of the positive climate group was found to be brief and productive; Angie quickly volunteered to edit the group's wiki, allowing the group to move through the planning phase at a relatively faster pace. Whereas the negative climate group was still engaged in high levels of planning in the second 30-minute time interval (see Figure 5), the positive climate group had begun to analyze the case. Having more time to solve the case may have allowed the positive climate group to engage in a higher frequency of monitoring, particularly in the last 30 minutes of collaboration, when the negative climate group was still more highly engaged in enacting the task (see Figure 5).

The initial planning session for the negative climate group was lengthy with back-and-forth orders among members to take up the editor role. Compared to the positive climate group who chose an editor within 3 minutes, the negative climate group took almost 10 minutes to identify an editor, delaying progress on the task itself. While deciding the editor, two group members who were ESL speakers stated concerns with difficulties in communicating due to language barriers, and thus avoided being the editor of the group wiki. The other two members—Steve and Jay—avoided the role on the basis of a lack of ability to type fast. It is possible being less prepared (see Theme 1) may have redirected the negative climate group's efforts away from establishing a productive socio-emotional climate towards focusing more on individual

competency. Due to time constraints, the editor role was delegated to Jay, who used an emoticon to express disappointment or apprehension regarding the decision. Group members did not overtly acknowledge Jay's emotional reaction, but instead promptly suggested they begin the task, indicating a lack of co-regulatory support when faced with an emotional challenge. The lack of commitment and negative tone portrayed early in the negative climate group may have been pertinent in establishing the climate for the group.

Emotions after initial planning. Coinciding with each group's regulatory actions in the earlier phases of collaboration, by the midpoint and through to the end of collaboration, valence of emotions demonstrated in the emotion check-ins was reversed between the two groups. Positive emotions dominated the positive climate group (3 of 4 members), and negative emotions dominated the negative climate group (3 of 3 reporting members), with one member in the negative climate group failing to complete the final two check-ins. In the positive climate group, the only negative emotion was expressed by the editor, Angie, who was anxious about time and feeling rushed. Recognizing Angie's concern for time, the other group members attempted to co-regulate her anxiety by re-assuring her the group was doing well for time and apologizing for the amount of work she was responsible for as editor. The positive climate group concluded the assignment with 3 of 4 members feeling confident they had performed well. Angie, however, continued to feel anxious, reporting in her final check-in *"I felt really rushed in my parts and I was unable to look over what the others were doing so I was unable to help and monitor."* Despite her feelings of anxiety, Angie expressed very high satisfaction with assignment progress and reported a positive atmosphere at the midpoint and end of collaboration, suggesting she held a positive perception of the collaborative experience. These positive evaluations were echoed by

the rest of the group, who were extremely satisfied and perceived a positive atmosphere at both times.

In contrast, with one member ceasing to report emotions at the end of collaboration, the negative climate group reported negative emotions ranging from moderate to very strong in intensity. As one member put it, "*[the group] did not get off to a good start*" (Sean, SEST2). As demonstrated in Figure 7, group members may have attempted to improve the negative atmosphere by also engaging in positive socio-emotional interactions after the first 30 minutes had passed (i.e., during the 30- to 45-minute time interval). These attempts, however, appeared unsuccessful as negative interactions persisted (see Figure 7) and appeared to adversely affect group members' satisfaction with progress, with reports in the midpoint and final SEST of being not very or only moderately satisfied. Furthermore, the negative climate group was unable to fully complete the task. At the end of the collaborative session, group members reported feeling frustrated/angry, doubtful, and disappointed with the quality of their work.

Summary. Overall, the negative climate group's functioning was characterized by a downward trajectory starting with a predominance of observed negative interactions in the early phase of collaboration leading to strong negative emotions in some members. The lack of evidence for co-regulatory support in this initial phase—where members should ideally recognize and attend to others' negative feelings—may have intensified the negative emotions and thwarted later attempts at amelioration. On the other hand, the smooth beginning observed in the positive climate group may have created a foundation of interpersonal trust ideal for sharing the management of emotions and group work—an observation that is consistent with our next theme.

Theme 3: Negative Emotions as a Constraint (*Condition*) for Shared Adaptation in the Face of a Challenge

Examining groups' regulatory behaviors during challenging episodes provides opportunity to distinguish effective from ineffective regulators (Järvelä et al. 2013). One design-based challenge of this online collaborative task was time constraints. When time becomes limited, execution of task-related activities may need to be adapted to the time constraint. Unfortunately, the negative climate group appeared to be unsuccessful at adapting under time pressure. Although they recognized the need to come up with a new plan—reported at midpoint check-in—the group failed to negotiate a new strategy and mitigated the situation by conceding to the editor's co-regulatory prompts and concentrating on individual work. In their rare moments of re-strategizing or adapting, the negative climate group was confronted with cohesion issues. In the following excerpt, Seiko's suggestion for re-strategizing by dividing the last questions was ignored by her group. Instead, Jay took over and told the group what to do, leaving little room for a group discussion about how to change their plan.

Jay:	were really running out of time!!
Seiko:	who is responsible for B let's divide the last things
Jing:	me *[responding to Seiko's question]*
Jay:	I'm just throwing something together for A.. you guys move on and we'll come back if theres time
Seiko:	ok
Steve:	i'm already working on memory and learning for when we get there
Jay:	good
Seiko:	so im in E
Jay:	give answers when youre ready

Towards the end of the collaborative session, the negative climate group switched to completing their work more individually than as a group (see Figure 6), demonstrating little evidence of a collective effort in adapting to task constraints. In contrast, under time pressure, the

positive climate group reconvened and re-examined their plan of attack as a team. When adapting their task-execution strategies, group members typically discussed details of the strategy, and enactment of a new strategy was often dependent upon group members' agreement to the delivery of that strategy. The excerpt below provides an example of how group members collectively planned and adapted their plan for enacting part of the assignment. The discussion was prompted when Jessica indirectly sought feedback by posing her suggestion for their strategy as a question. About halfway through the excerpt, Jessica noted an issue with the strategy, which prompted the group to adapt their plan.

Jessica:	I think for the next portion and for the reading we should all try to focus mostly on our core concept?
Angie:	Yes i think so..
Suparna:	Yeah sounds good
Angie:	But mine is memory so where does that fit in?
Jessica:	Memory is section C
Tom:	See if he has trouble moving from sensory to working to long term memory
Angie:	Oh right thank u! Ok let's do that then
Jessica:	There's more sections than us though. We have to write 6 things mine is A
Angie:	I have 2
Suparna:	Mine is B
Angie:	And e is just in general
Tom:	I have D and we collaborate on E
Suparna:	We can work on those at the end
Tom:	Yeah, whoever has C does two
Suparna:	Yeah.
Angie:	Yes

When individual reports regarding planned approaches to regulating emotions were inspected (SEST data), a consistent theme was observed. The positive climate and negative climate groups differed in two important ways. First, members of the positive climate group were well aligned in terms of plans to regulate their emotions by focusing on the task, with 3 of 4 members planning this strategy at the beginning and midpoint of the task. In contrast, members

of the negative climate group planned a variety of strategies at the beginning of the task. By midpoint, creating a good plan was identified as a strategy for all three reporting members, suggesting something was not working and needed to be changed. However, members of the negative climate group seemed to have different ideas about what a "good plan" was as evidenced in the chat—Jing wanted to divide the remaining work and Jay wanted members to focus on completing their already assigned work. Second, when reporting who should enact the strategies, the majority of responses in the positive climate group indicated the group should enact the strategies together, whereas the majority of responses in the negative climate group indicated the strategies should be enacted by the individual group member alone or each group member individually. It was not surprising to find the negative climate group lacking evidence of co- or shared regulation for decreasing negative emotions or maintaining/increasing positive emotions, as their plans for regulation were not viewed as part of the group's responsibility.

The above contrasting features suggest intentions and efforts to collectively execute a strategy are crucial in collaboration, particularly when the group encounters a setback. Furthermore, attempts to adapt to task constraints should not be communicated in a negative tone as that could create friction leading to dissolution of collective effort among members.

Theme 4: Encouragement and Motivational Statements as an Effective Strategy (*Operation*) for Creating a Positive Climate

A neglected aspect of instruction in collaborative learning is how students should be interacting with each other, particularly with respect to the socio-emotional dimension (Johnson and Johnson 1991; Kreijns et al. 2013). Often, the focus is on how students interact with the material presented in collaborative work or how group members interact with each other within the cognitive dimension or task context. Our examination of the co-occurrences of codes

revealed that, within all three modes of regulation, the positive climate group demonstrated a higher frequency and proportion of positive socio-emotional interactions (see Figure 8). Closer inspection of the positive interactions in the positive climate group revealed that these interactions were comprised primarily of encouraging participation and motivation (f = 136), with 42.6% in the form of co-regulatory supports or requests for maintaining engagement in the task. Such encouraging interactions were not common in the negative climate group (f = 46), with a smaller proportion (28.2%) in the form of co-regulatory actions, possibly because the group was less proficient at engaging in such conversations, especially in the presence of one domineering group member. The excerpt below is an example of how members in the positive climate group encouraged each other. The conversation began with Jessica asking for feedback on her answer. The group then acknowledged Jessica's ability to construct a strong answer.

Jessica:	Is that good?
Tom:	Just bang out what you were just saying
Jessica:	True yeah brilliant
Suparna:	Yeah everything that was mentioned before was good.
Tom:	I think Jessica has a good grasp on this.

The consistent supportive actions observed in the positive climate group were also acknowledged by the individual group members. In the SERT, all four members described a positive and supportive working atmosphere, in which they communicated and worked well together. In describing that atmosphere, group members reported positive emotions of happiness or confidence, with the exception of Angie, who recalled feeling stressed. Angie's stress, however, was likely related to her role as editor and did not reflect the positive atmosphere she perceived in the group. Angie thought her group was unaware of her stress, but predicted the group would have been supportive if they had known. On the other hand, members in the negative climate

group recalled feeling negative emotions of stress and doubt. Seiko indicated the group did not know how to collaborate, which was consistent with the negative socio-emotional interactions observed in the chat logs.

Summary of Findings

The preceding themes describe the prominent factors that may contribute to a positive or negative socio-emotional climate. Figure 9 demonstrates how the findings might be embedded in the COPES model. Given the dynamic nature of COPES, it is important to note these figures represent a snapshot of COPES that may be observed at one time. Theoretically, the items listed in each box are continuously changing and shifting between boxes as groups move through the collaborative task. For example, the products of positive or negative emotions become conditions as groups move into the next iteration of regulation. From our findings, we posit incoming conditions set the foundation for a positive or negative collaborative experience, with these conditions contributing to the group's ability to regulate their emotions during the initial phase of collaboration. The emotions produced during early collaboration then become conditions influencing future regulatory actions, such as shared adaptation in the face of a challenge. Finally, our observations of the groups' socio-emotional interactions throughout the whole session highlight the importance of communicating in a positive tone and minimizing negative interactions. Although both groups engaged in more positive than negative socio-emotional interactions, the frequency and proportion of negative interactions was higher in the negative climate group compared to the positive climate group (see Figure 7 and Table 7 in the Appendix). This suggests that, despite attempts to interact positively, the presence of persistent negative interactions may have detrimental effects, which can be seen in the negative emotions and lower satisfaction reported by members of the negative climate group.

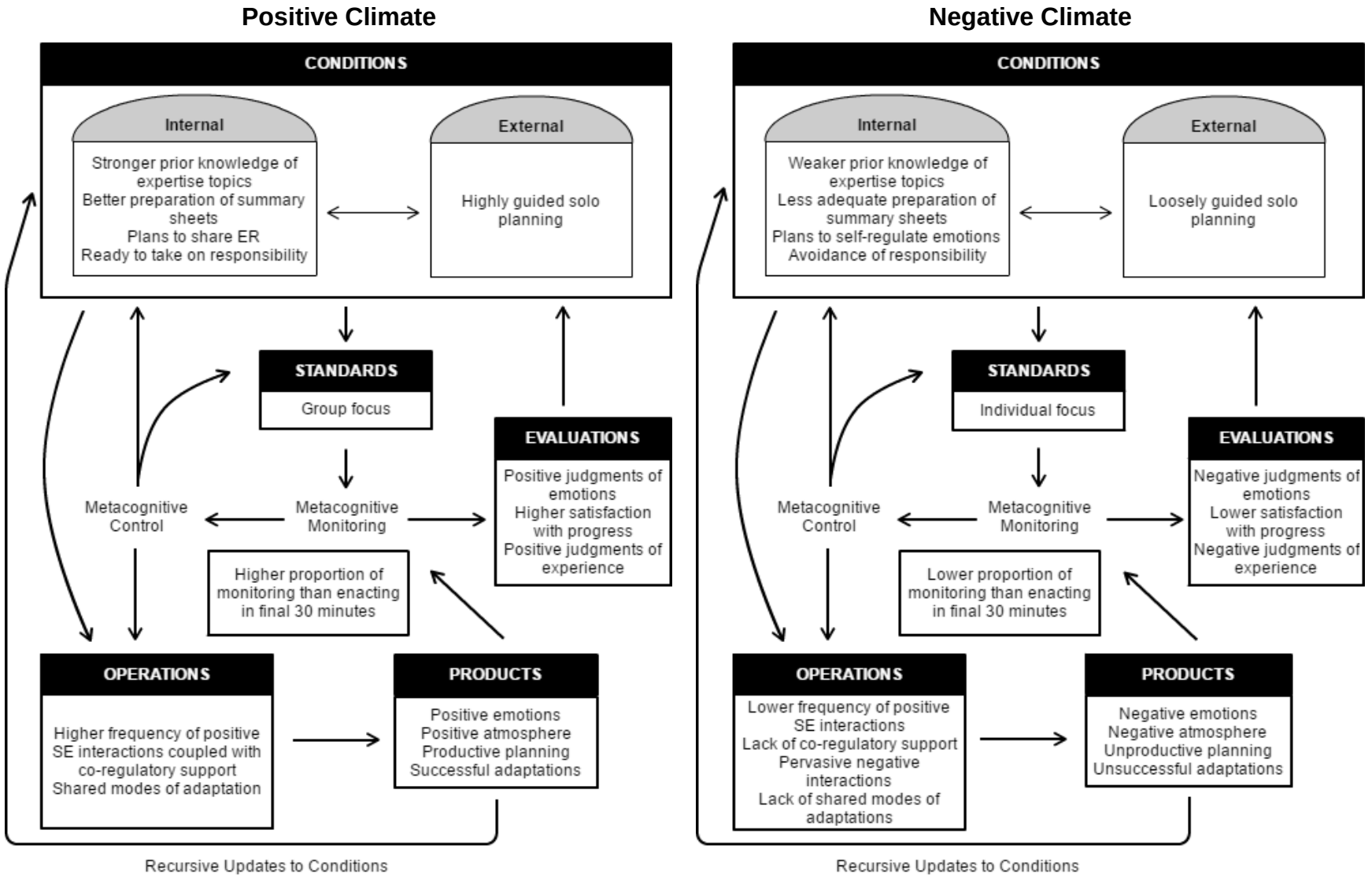

Fig. 9 Example of COPES occurring in each group.

Implications and Future Directions

This study set out to examine the regulation of socio-emotional aspects of collaboration in two groups with contrasting socio-emotional climates (positive vs. negative). Our in-depth analysis of various data sources led us to identify four emerging themes: (a) incoming conditions as a foundation for creating a positive collaborative experience, (b) regulation of emotions during initial planning, (c) shared adaptation in the face of a challenge, and (d) encouragement and motivational statements as an effective strategy in sustaining a positive socio-emotional climate. Overall, these findings lend support to theoretical accounts positing emotion regulation in collaboration as an active dynamic process unfolding across the individual and group level, where a multitude of conditions, operations, products, evaluations, and standards continuously interact over time (Hadwin et al. 2011; Järvelä and Hadwin 2013). The fluctuation and interaction of regulatory processes, regulatory modes, and socio-emotional interactions within the online environment (see Figures 5 to 8) contributed to the groups' contrasting socio-emotional climates in interesting ways. Our careful analysis demonstrates that a positive socio-emotional climate is possible when individual members accept personal responsibility to prepare for the task, actively engage in recognizing and supporting emotions that are experienced within the group, and collectively maintain shared responsibility to conquer challenging circumstances.

Several areas of research should be further examined. First, this study indicates that instructional supports for members' *self*-regulation of learning in the service of the shared process are necessary for the group's productivity. This finding also suggests that creating a positive socio-emotional climate is not necessarily dependent upon establishing a strong social connection among group members outside of the task as argued in previous research (e.g., see Kreijns et al. 2013). The role self-regulation plays in collaboration aligns well with recent

research by Panadero et al. (2015), who found that individual regulatory skills (SRL) positively predicted group regulation (SSRL). Hence, support tools in collaborative contexts should not only be geared towards supporting the collective group, but should also support individual work within the group.

The current study also demonstrated the initial planning phase was a crucial window of time in the online collaborative session, indicating that appropriate scaffolds in the early stage of collaboration should be further examined. In this study, to support the development of shared and accurate task perceptions among group members, groups were provided an implicit guidance tool summarizing individual members' responses to the solo planning tool. No guidance tool was, however, targeted towards groups' motivation and emotion. We argue that awareness of in-the-moment emotions can be useful for members to promptly respond to unfavorable emotions within the group, ultimately taking joint control of the group's emotional climate. Therefore, guidance tools introduced in the initial phase of group planning should not only include members' perceptions of the task, but should also include other socio-emotional variables, which together can promote conversations about priorities, expectations, and motivations prior to engaging in the collaborative assignment (e.g., Järvelä et al. 2015).

In a similar vein, findings from this study point to the potential effect individual planning support can have on collaborative groups' emerging socio-emotional climate. In particular, we found the two groups differed in terms of the level of individual planning support they received. To follow up on this, we compared the conditions assigned to all six groups who met our initial selection criterion. Of the four groups who met the criteria for a positive climate (all reporting a positive experience), two groups came from the high individual support condition. In contrast, the two groups who met the initial criteria for a negative climate (all reporting a negative event),

both came from the low individual support condition. This trend indicates the level of support provided for individual planning may influence learners' engagement and, consequently, the socio-emotional climate experienced by the group. Although we did not observe major differences in group-level task perceptions between the two groups, future research should examine whether types of planning support affect socio-emotional climate in consistent ways across a large number of groups (see also Järvelä et al. 2016). Beyond planning, groups' ability to collectively adapt in challenging situations may be an important factor distinguishing effective from ineffective regulators (see also Winne and Hadwin 2008). Groups' adaptations in response to challenging situations can become important points for identifying the needs for regulatory supports within teams. Hence, we call for further research to examine groups' regulatory pathways from the point of encountering a challenge through to its resolution (or lack thereof).

Findings in the last theme suggest a positive socio-emotional climate is built upon feelings of trust portrayed through respectfully encouraging and supporting one another's participation and motivation. Interacting positively may not come naturally to group members and is, therefore, a skill that should be pedagogically encouraged and supported by instructors. Previous evidence suggests that effective collaborative learning largely depends on the quality of student interactions (Dillenbourg and Tchounikine 2007; Kobbe et al. 2007) and teachers' guidance in fostering beneficial interactions amongst collaborators (Webb 2009). Thus, supporting learners' regulation of emotions and motivation in collaboration is as important as supporting knowledge building between members in a team. One support instructors could provide is to proactively discuss with students interactions that might impede or benefit group functioning, also accounting for cultural differences that might be at play (see Volet 2001). Encouraging students to think about such topics beforehand may prompt them to make plans for

engaging positive socio-emotional interactions from the start and navigating negative socio-emotional experiences when the need arises.

One contribution of our study was examining socio-emotional interactions and regulation in a purely text-based collaborative session—a setting that may elicit different socio-emotional and regulatory processes when compared to face-to-face settings. For example, coordinating statements where the main purpose is to situate oneself and others in the learning environment (i.e., orienting) and explicitly expressing emotions using text emphasis and emoticons may be used more frequently in virtual collaboration. Investigating regulatory processes in online environments may, therefore, require that additional or different processes be considered. In other research, it has been argued that computer-mediated collaboration is often more task oriented with socio-emotional interactions decreasing as groups move along (e.g., Orvis et al. 2002), whereas face-to-face collaboration provides more opportunities for personal and socio-emotional interactions (Walther 1992). Though the decrease in socio-emotional interactions may be true for the negative climate group in our study, positive socio-emotional interactions remained continuously present in the positive climate group—a finding that is consistent with Kwon et al.'s (2014) 'good collaborators' (see also Malmberg et al. 2015). In other words, purposeful engagement in socio-emotional interactions and regulation of socio-emotional challenges seemed to be more dependent on group members' regulatory skills than the medium of collaboration itself. Above all, researching socio-emotional interactions and regulation in online environments provides opportunities for researchers to unpack those processes at several granularity levels. Apart from describing the types of regulatory and socio-emotional activities in collaborative groups (e.g., Kwon et al. 2014) and examining the influence of such activities on performance (e.g., Janssen et al. 2010), the sequential nature and the temporality of socio-

emotional interactions and regulatory actions can also be inspected. However, challenges in using online mediums do exist and include (a) technical difficulties in judging the temporal scope of meaningful socio-emotion and regulation episodes for data analysis and (b) the lack of non-verbal displays that may provide additional information about how group members are feeling and responding to the situation. Additional measures of learners' emotional processes may be useful for providing insight into learners' emotional reactions during collaboration, such as the self-report tools implemented in our study.

Another consideration for future research is the cultural or language challenges that afford or constrain the development of a positive socio-emotional climate. In our research, the negative climate group included two English-as-second-language (ESL) students who clearly expressed concern with their language skills. It is possible the focus on their perceived incompetence became a potent condition, changing the negative climate group's productivity. Another possibility is the ESL learners in the negative climate group may have carried a different set of culturally-bound working styles (see Volet 2001), creating differences in learning trajectories. Future research could examine to what degree culture or language differences interact with emotion regulation in group contexts.

Given the exploratory nature of this study, we focused on the first of two graded collaborative assignments in the course. It would be interesting to see how the groups' regulatory behaviors and socio-emotional interactions varied from the first collaborative experience to next. Presumably, the products of working together for one assignment would become conditions influencing the next collaborative cycle. For example, perceptions of a negative working climate may have prompted the negative climate group to engage in more detailed planning in the next collaborative assignment. Research is still being conducted to test the validity of that assumption.

Moreover, we did not explicitly examine groups' regulation in terms of quality because we were primarily interested in examining the change over time and interplay of regulatory actions. Examining the quality of regulatory processes was beyond the scope of this paper, but is another avenue of further research.

Finally, our selection of two cases demonstrating extreme differences in group members' perceptions of salient socio-emotional climate allowed us to generate two contrasting profiles, providing insights into the factors that differentiate a positive climate from a negative climate. Analysis of other group profiles, such as a mixed climate, may lead future research to demonstrate different salient factors that contribute to such climates. Regardless, our findings generally corroborate and extend those of other studies, thus offering a meaningful contribution to the research in this area. This exploratory study could lead to research with other groups and different contexts in order to further understand the regulatory mechanisms that contribute to productive and equally satisfying collaboration.

Conclusion

In summary, this cross-case analysis opens the door to many possibilities for research in regulation of collaborative learning. These possibilities span from (a) supporting regulation through encouraging higher levels of self-regulation prior to group work, providing scaffolds in the early stage of collaboration, and prompting groups to interact in a positive and respectful manner to (b) researching groups' regulation through challenging episodes and enactment of socially-shared regulation of learning. Certainly, the findings of this cross-case analysis demonstrate a need for researchers to further examine the important associations between groups' regulatory behaviors and the nature of groups' socio-emotional processes at a large scale.

Appendix

Table 7 Code frequencies (and proportions) across coding categories

Codes	Positive climate	Negative climate
Regulatory processes	**466**	**339**
Planning	97 (20.8%)	81 (24.0%)
Enacting	91 (19.5%)	84 (24.9%)
Monitoring	145 (31.1%)	90 (26.6%)
Orienting	109 (23.4%)	70 (20.7%)
Adapting	13 (2.8%)	3 (0.9%)
Off-task	11 (2.4%)	10 (3.0%)
Modes of regulation	**474**	**344**
Self-regulation	91 (19.2%)	83 (24.1%)
Co-regulation	164 (34.6%)	82 (23.8%)
Co-regulatory request	13 (2.7%)	11 (3.2%)
Socially-shared regulation	206 (43.5%)	168 (48.8%)
Socio-emotional interactions	**205**	**118**
Positive interactions	190 (92.7%)	69 (58.5%)
Apologizing	6 (2.9%)	2 (1.7%)
Humor/laughter	13 (6.3%)	5 (4.2%)
Encouraging participation / motivation	136 (66.3%)	46 (39.0%)
Promoting trust & cohesion	35 (17.1%)	16 (13.6%)
Negative interactions	3 (1.5%)	30 (25.4%)
Discouraging participation / motivation	0 (0.0%)	9 (7.6%)
Low cohesion or pushing one's perspective	2 (1.0%)	8 (6.8%)
Pressuring others	1 (0.5%)	13 (11.0%)
Expressing emotions	12 (5.9%)	19 (16.1%)

Note: Proportions are of total category frequency.

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Individual and Group Strategies for Regulating Emotions in Online Collaboration

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Abstract

This study examines the strategies students report using to regulate their emotions during computer-supported collaborative learning (CSCL) in the context of different group planning conditions. Undergraduate students (N = 188) in a learning-to-learning course were assigned to one of three planning visualization conditions and completed two CSCL assignments in groups of 3 to 5. After completing each assignment, students reflected on a positive or negative experience, identifying a salient emotion and describing individual and group strategies to regulate that emotion. Analyses of coded strategies and students' evaluations of the effectiveness of those strategies indicated that students used a variety of strategies, with the use and effectiveness varying by level of strategy (individual vs. group) and valence of emotion (positive vs. negative). Planning support also appeared to make a difference in emotional experiences. Students in groups that received less support demonstrated a greater positive change in emotions and evaluations of emotion regulation strategies from one assignment to the next. This study takes the first step towards developing an evidence-based strategy inventory to support collaborative groups to regulate emotions and highlights the importance of taking planning into account when examining emotion regulation during collaboration.

Keywords: emotion regulation strategies; planning; computer-supported collaborative learning; scripting; group awareness tools

Individual and Group Strategies for Regulating Emotions in Online Collaboration

Previous research has established the importance of emotions in group work. For example, findings demonstrate emotions are linked to performance, social loafing, group efficacy, and cohesion (Duffy & Shaw, 2000); positive group interactions (Linnenbrink-Garcia, Rogat, & Koskey, 2011); regulatory processes such as planning and adapting (Bakhtiar, Webster, & Hadwin, 2018); cognitive and metacognitive processes (Duffy et al., 2015), and high-level co-regulated knowledge construction (Volet, Summers, & Thurman, 2009). However, few studies have examined the ways group members regulate or respond to emotions encountered during computer-supported collaborative learning (CSCL). In this study, we aim to examine (a) the types of strategies students use during collaboration to regulate their emotions and (b) the effectiveness of those strategies. A primary goal of this research is to set the stage for the development of an evidenced-based strategy inventory that can be used to support collaborative teams to regulate emotions that arise during teamwork.

Regulating Emotions in Collaborative Learning

Group work can present novel and challenging experiences that elicit emotional reactions and require group members to engage regulatory processes to manage those affective states in order to progress in an optimal way (Järvenoja, Volet, & Järvelä, 2013; Wosnitza & Volet, 2005). To better understand the processes necessary for successfully navigating these emotional experiences in collaboration, we ground our work in a regulation of learning perspective. In particular, Winne and Hadwin's (1998, 2008) model of self-regulated learning contains four weakly sequenced, recursive phases that describe how students progress through a learning task. The first phase consists of developing task perceptions, which are translated into task-specific goals and plans in the second phase. In the third phase, students strategically select and enact

tactics to achieve their goals. Finally, in the fourth phase, students adapt their learning as needed within and across tasks on the basis of metacognitive monitoring and evaluating. In collaborative contexts, this model has been extended to take into account the social aspect of the situation. In addition to self-regulated learning (SRL), Hadwin and colleagues (Hadwin, Järvelä, & Miller, 2018; Järvelä & Hadwin, 2013) posit that successful collaborative learning requires co-regulated learning (CoRL) and socially-shared regulation of learning (SSRL). More specifically, group members need to regulate their own learning (SRL) to achieve personal and group goals, co-ordinate and prompt regulatory processes of one or more other group members (CoRL), and engage regulatory processes together with their group to achieve shared outcomes (SSRL).

Regulating emotions in collaborative contexts can be viewed from the perspective of Winne and Hadwin's (1998, 2008) model. In particular, the cyclical process of regulation described by their model is propelled by five features that characterize each phase, denoted by the acronym COPES. Students enter each phase with a set of internal and external *conditions* that influence engagement in that phase. *Operations* refer to the ways in which students process information and work on the task. The outcomes resulting from these operations are called *products*. Finally, *evaluations* are made by students when they compare the products to *standards*. In the COPES architecture, emotions are considered both conditions, providing context for engagement in each phase, and products, resulting from engagement in each phase. When students perceive a need to regulate their emotions, the operations they engage will be directed towards this goal. For example, in a collaborative context, Bakhtiar et al. (2018) posit that socio-emotional interactions can be considered outward instantiations of cognitive operations resulting in socio-emotional products, including emotions and socio-emotional climate. In this study, we aim to build an inventory of strategies—including but not limited to

socio-emotional interactions—that students can enact individually and with their group to positively impact their emotions and progress during collaboration.

Research examining emotion regulation in collaboration is burgeoning (e.g., Ayoko, Konrad, & Boyle, 2012; Bakhtiar et al., 2018; Järvenoja & Järvelä, 2005, 2009; Järvenoja, Järvelä, & Malmberg, 2017; Näykki, Järvelä, Kirschner, & Järvenoja, 2014; Panadero, Kirschner, Järvelä, Malmberg, & Järvenoja, 2015). Many of these studies have been conducted by Järvelä, Järvenoja, and colleagues. For example, Naykki et al. (2014) examined emotion regulation strategies in video recordings of a group of university students who experienced socio-emotional challenges. They used two emotion regulation frameworks (Gross & Thompson, 2007; Op 't Eynde, De Corte, & Verschaffel, 2007) to describe the focus of group members' regulatory actions. Järvenoja et al. (2017) examined the use of a mobile application tool to support emotion and motivation regulation during face-to-face collaborative learning. They did not, however, examine the specific strategies employed by individuals or groups to regulate emotions and called for further research into shared strategies. They also focused their analysis on "episodes with clear evidence of socio-emotional interaction" (Järvenoja et al., 2017, p. 9), but acknowledged that emotion regulation can occur outside of these events.

The current study extends this area of research to describe specific types of individual and shared strategies students use and their perceived effectiveness in an online—rather than face-to-face—collaborative context. Not only might CSCL environments present different emotion-eliciting challenges than face-to-face environments, but the expression and regulation of emotions might also differ, particularly when group members are limited to chat-based communication where traditional non-verbal cues, such as facial expressions and body language, are absent. The proposed research seeks to address this gap by inviting students to reflect on

what they did individually and what their groups did to regulate an emotion they experienced during collaboration.

Importance of Planning for Collaboration

Because we view emotion regulation as one facet of the broader process of regulating learning, we also aimed to examine the relation of other processes to students' emotion regulation. Our past research findings suggest planning makes an important contribution to subsequent collaborative processes. In particular, in a case study of two groups with positive vs. negative socio-emotional climates, Bakhtiar et al. (2018) found that individual preparation and planning may have been a contributing factor to the subsequent socio-emotional climate. Students in the overall positive climate group received a highly guided individual planning tool, whereas students in the overall negative climate group received a loosely guided individual planning tool. Although students in the positive climate group entered the task with fewer positive emotions than students in the negative climate group, their emotions switched during collaboration, with students in the positive group ultimately reporting more positive emotions. In another study with the same sample of students as the current study, Hadwin, Bakhtiar, and Miller (2018) examined the impact of group planning support in the form of visualizations of summarized individual planning perceptions. After completing individual planning tools, group members together completed a group planning tool that contained either no visualization or one of two versions of a graph summarizing their individual planning responses. Findings from this study revealed that students who received no visualization support reported more severe planning challenges and less successful strategies compared to students who received one of the two different visualizations. These findings point to the importance of planning in collaboration and indicate this critical aspect of regulation should be taken into account when investigating the

emotional experiences of group members. The current study builds on these previous studies to further examine how different levels of planning support relate to emotion regulation.

Planning consists of the first two phases of Winne and Hadwin's (1998, 2008) model and is a critical process of productive regulation. In group work, planning should occur at the individual and group level (Hadwin et al., 2017). Failing to engage in planning or to adequately plan can have adverse effects on collaboration. For example, Rogat and Linnenbrink-Garcia (2011) found in groups of upper-elementary students that jumping into a task without devising a clear plan led to greater use of regulatory resources dedicated to planning or monitoring the plan. In the same study, the only group demonstrating high quality social regulation (a) engaged in high quality planning which seemed to facilitate content monitoring and avoidance of challenges, and (b) consistently engaged in positive socio-emotional interactions. High quality social regulation was defined as frequent and high quality instances of planning, monitoring, and behavioural engagement along with positive socioemotional and collaborative interactions that allowed the group to focus on content monitoring.

Although planning is foundational for regulating learning, little research has taken into account the impact of planning on group members' emotional experiences during collaboration. To address this gap, the current study examines and compares individual and group strategies reported by individual group members across different planning support intervention groups.

Supporting Regulatory Processes Through Scripting and Awareness Tools

Researchers in the area of collaborative learning emphasize the importance of developing and evaluating tools and supports for scaffolding individual and group-level regulation in CSCL contexts (e.g., Järvelä et al., 2015, 2016; Miller & Hadwin, 2015a). As Järvelä et al. (2015) propose, these tools should "enable learners to increase awareness of their own learning

processes and that of others to effectively and efficiently learn alone and in groups" (p. 131). Initial research in this field focused primarily on supporting cognitive aspects of collaboration (e.g., knowledge construction) and interaction processes (Järvelä et al., 2015, 2016), but a growing interest in supporting regulatory processes has prompted researchers to begin to develop and utilize tools aimed at supporting processes such as planning (Hadwin, Bakhtiar, et al., 2018; Miller & Hadwin, 2012, 2015b), emotion/motivation monitoring and regulation (Järvenoja et al., 2017; Näykki, Isohätälä, Järvelä, Pöysä-Tarhonen, & Häkkinen, 2017), and reflecting (Splichal, Oshima, & Oshima, 2018). Consistent with this emerging area of research, the tools examined in the current study aimed to enhance group or individual awareness in order to (a) prompt deeper-level group planning discussions through the use of visualizations that summarize and display individual perceptions about the task and (b) promote large-scale adaptation through the use of a reflective tool scripting students to describe and evaluate their responses during salient emotional experiences (Miller & Hadwin, 2015a). This study brings together two technological supports (i.e., a group planning tool and an individual reflection tool) serving different regulatory purposes and examines how they may interact as part of the complex regulatory system required for productive collaboration.

Purpose and Research Questions

The purpose of this study was to (a) qualitatively identify and categorize the strategies students report using to regulate their emotions during an online collaborative task and (b) compare the frequency and effectiveness of those strategies across different group planning conditions. Three research questions guided the analysis:

1. What strategies did students report using to regulate a salient emotion during an online collaborative problem-solving task?

2. How effective were strategies for regulating emotions and facilitating progress?
3. Did reports of emotions and emotion regulation strategies differ under three types of group planning support?

The first two research questions were exploratory in nature; thus, no hypotheses were made. Given past research findings indicating students who receive less planning support encounter more challenges, we expected students in the current study who received less planning support to report more negative emotions and less success with their emotion regulation strategies.

Methods

Participants

Participants were 188 undergraduate students (110 females and 78 males) registered in a first-year learning-to-learn course. The average age of participants was 19.6 years (*SD* = 2.1), with the majority of participants in their first year (62.9% of 186 reporting students) and from the faculty of Social Sciences (53.2% of 188 students). Using self-regulated learning as a framework, the learning-to-learn course introduces students to theory, research, and practice in effective learning and provides opportunities for students to apply those concepts to their own university learning. Each week, all students attend one lecture at the beginning of the week and then break off into smaller groups for applied lab activities later in the week. One set of lab activities required students to work in groups of 3 to 5 to complete two computer-supported collaborative problem-solving assignments. Groups were assigned by lab instructors who attempted to optimize heterogeneity in terms of past quiz performance, gender, and English language skills. Group composition and course enrollment fluctuated over the course (e.g., students dropped the course), resulting in 48 groups for the first collaborative assignment and 45 groups for the second collaborative assignment.

Collaborative Assignments

Each collaborative assignment required groups to examine a scenario of a struggling student with the goals to (a) analyze the fictitious student's studying processes using concepts covered in the course to date and then (b) identify the root of the problem (Assignment 1) or recommend strategies to address the problem (Assignment 2). More specifically, in Assignment 1, groups received a one-page scenario of a student preparing for, writing, and submitting a research paper for his history course. The scenario included issues related to five topics covered during the first half of the course: self-regulated learning, task understanding, goal-setting and monitoring, regulating time and procrastination, and regulating motivation. Part A of the assignment contained a list of course concepts within each of those five topics, and groups were asked to specify an example from the scenario of each concept and explain if it was a strength or weakness. In Part B, groups were asked to first identify the root of the student's problem and then explain why that was the main problem using course concepts and specific examples from the scenario.

In Assignment 2, groups received a one-page scenario of a student preparing for, studying, and writing the final exam for her psychology course. Issues in this scenario were related to five topics covered in the last half of the course: self-regulated learning, memory and attention, learning and processing for meaning, regulating test preparation and test taking, and regulating reading and notetaking. In Part A of the assignment, groups were asked to first identify the student's five most important problems, provide specific quotes from the scenario demonstrating the problem, and explain why it was a problem using course concepts. Then groups were asked to identify and justify the root of the problem. In Part B, groups were asked to propose one strategy focused on planning and one strategy focused on enacting (related to

reading, notetaking, test preparation, or test taking). In addition to describing each strategy, groups were asked to explain why the strategy works and why the strategy would be important for the student.

The assignment was structured to unfold over three work sessions corresponding to three phases of regulating collaborative learning: (a) planning, (b) enacting the collaborative problem-solving task, and (c) reflecting (see Figure 1). All tasks and communication among group members took place online.

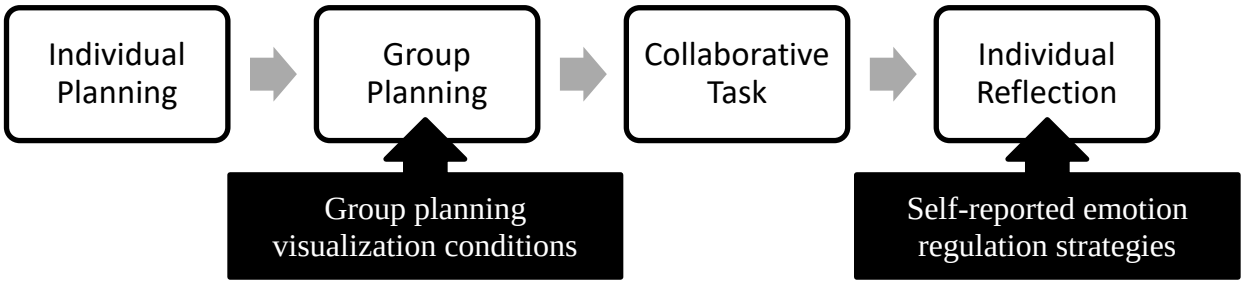


Figure 1. Phases of collaborative assignment. Groups were assigned to one of three visualization conditions for group planning. Self-report data about individual and group emotion regulation strategies were collected in the individual reflection.

Phase 1: Planning. The first phase comprised individual and group planning for the collaborative problem-solving task. Group members individually completed a solo planning activity that scripted them to analyze the task and create a plan for tackling the problem-solving task through a series of pre-stocked and open-ended items. Next, groups communicated via a chat tool during one of their labs to complete a group planning activity, which contained similar questions to the solo planning activity, with the only difference being loosely structured, open-ended response fields. Collaborative groups were assigned to one of three visualization

conditions for group planning. Visualization conditions displayed information to the group about individual team members planning perceptions in order to stimulate more transactive and productive group planning discourse. The quantified condition supported group planning by visually displaying the number of group members who identified each criteria or standard from the individual planning activity (see Figure 2A). The nominal condition supported group planning by visually displaying all criteria or standards identified by someone in the group during individual planning without any quantification about the number of team members selecting it (see Figure 2B). Finally, groups in the no visualization condition received no visual summaries of their individual planning activity responses at all.

The final question in the group planning tool asked the group to create a plan for preparing summary sheets for each of five course topics relevant to Assignment 1 (SRL, task understanding, goal setting and self-monitoring, regulating time and procrastination, and regulating motivation) or Assignment 2 (SRL, memory and attention, learning and processing for meaning, regulating test preparation and test taking, and regulating reading and notetaking).

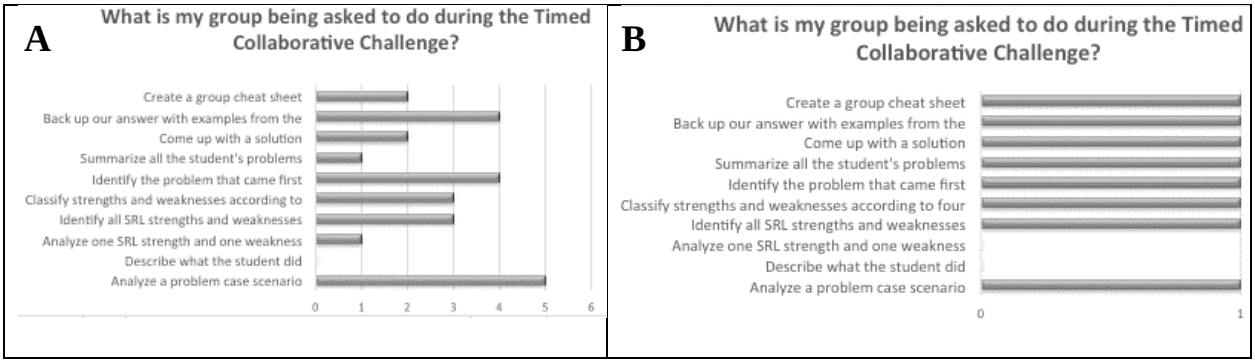


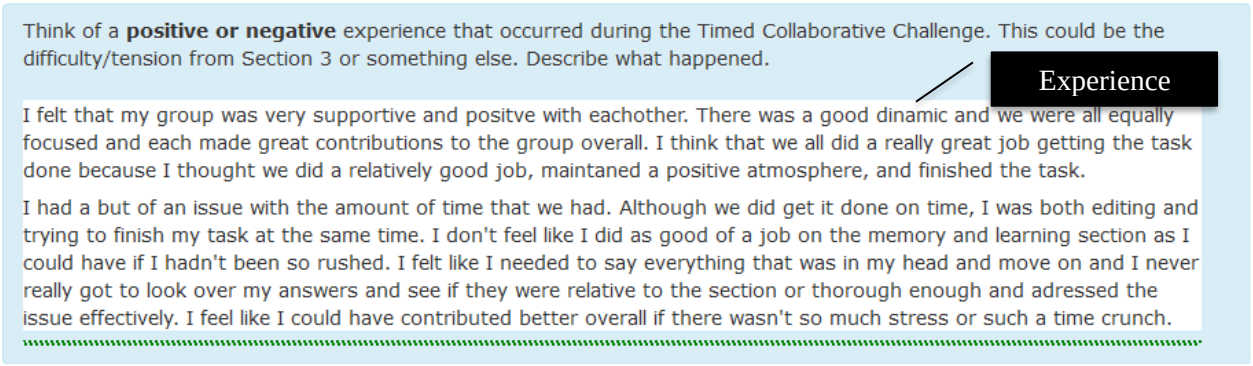
Figure 2. Quantified visualization (A) and nominal visualization (B) of individual group members' task perceptions of explicit task features.

Phase 2: Enacting the collaborative task. In the second phase, groups completed the collaborative problem-solving task during one 90-minute work session. Students were assigned to computer labs across campus and were not necessarily in the same room as their group mates.

Group members communicated via a chat tool to discuss assignment questions. Collaborative responses were documented using a shared wiki, editable by only one person at a time, but viewable by everyone once changes were saved and screens were refreshed.

At the beginning, middle, and end of the collaborative task, group members were prompted to individually complete the Socio-Emotional Sampling Tool (SEST; Webster & Hadwin, 2014), a narrative constructor tool prompting students to (a) identify their feelings in the present moment and (b) identify a strategy they could use to regulate that feeling. Drop down lists of options were provided for identifying the emotion and the strategy. Although these data were not analyzed for this study, students had access to their responses on the SEST when reflecting upon and describing their emotion regulation strategies in the individual reflection (described next).

Phase 3: Reflecting. Within five days of the collaborative task, students completed a Socio-Emotional Reflection Tool (SERT; Webster & Hadwin, 2012). The SERT is a narrative constructor tool that prompts students to (a) describe a positive or negative experience that occurred during the in-class collaborative work session, (b) report the main emotion during that experience, (c) describe what strategies they used to regulate the emotion, and, (d), rate the effectiveness of that strategy. Seven items from the SERT were used for analysis in this study (see Figure 3):



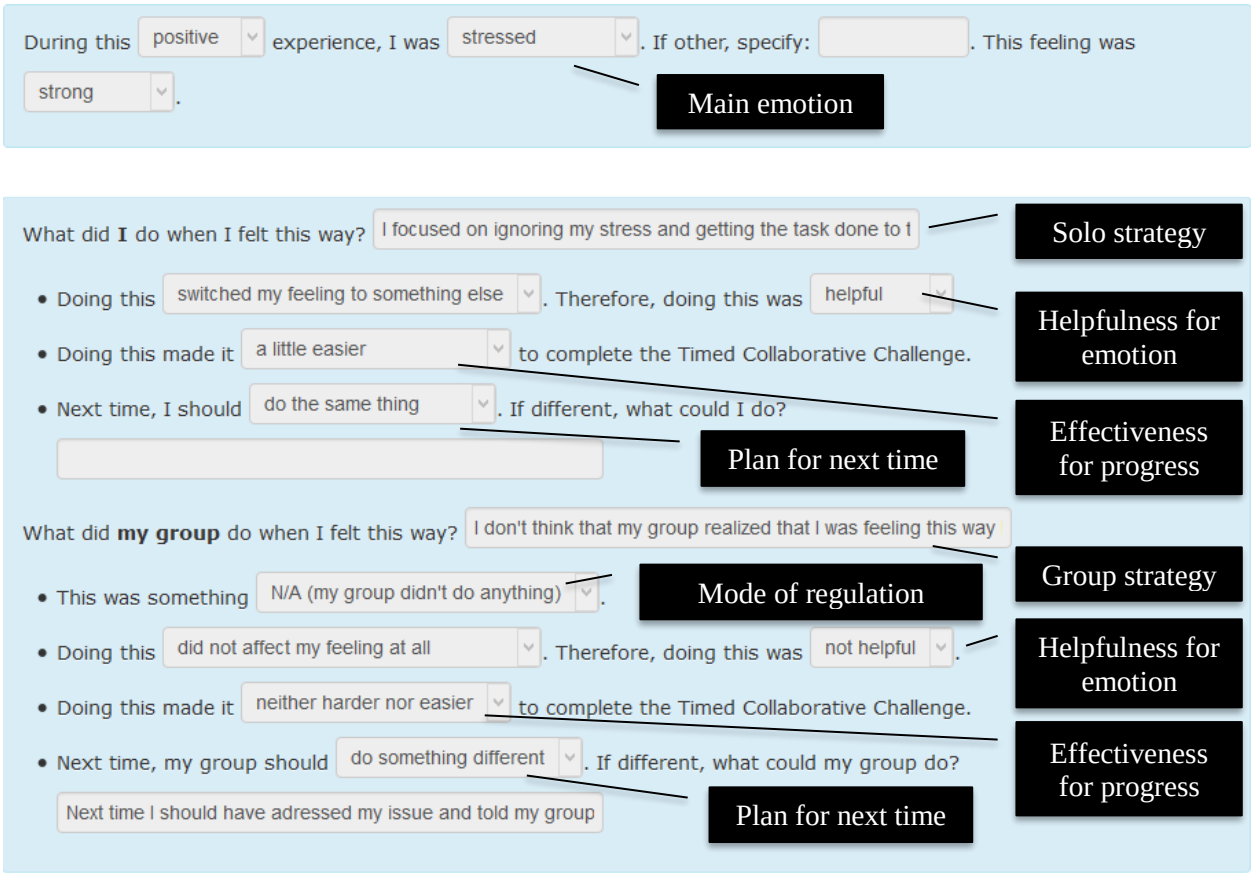


Figure 3. Items from the SERT.

Main emotion. Students reported a salient feeling during the positive or negative experience by selecting one emotion from a dropdown list containing six positively valenced emotions (calm, confident, excited, focused, happy, optimistic) and six negatively valenced emotions (anxious, disappointed, doubtful, frustrated/angry, stressed, worried). The option *other* could be selected if none of the emotions applied. For analysis, emotions were grouped according to valence (positive or negative).

Solo emotion regulation strategy. Students described what they did individually when they experienced their main emotion in an open text field.

Group emotion regulation strategy. Students described what their group did when they experienced their main emotion in an open text field.

Mode of group emotion regulation. In addition to describing what their group did, students indicated whether this was an action (a) they did as a group, (b) each of their group members did, or (c) their other group members did. If their group did nothing, they chose N/A.

Helpfulness for regulating emotion. For both the individual and group strategies, students reported if the strategy (a) increased, decreased, switched, maintained, or did not affect their feeling at all and (b) was *helpful* or *not helpful*.

Effectiveness for progress. For both the individual and group strategies, students reported if the strategy made it (a) a lot harder, (b) a little harder, (c) neither harder nor easier, (d) a little easier, or (e) a lot easier to complete the collaborative task. For analysis, items were recoded on a scale from -2 (a lot harder) to 2 (a lot easier).

Findings

What Strategies Did Students Report Using to Regulate a Salient Emotion During an Online Collaborative Problem-Solving Task?

Coding of solo and group strategies. A preliminary a priori coding scheme was generated by reviewing and consolidating coding schemes used across past studies in the literature (Ayoko et al., 2012; Bakhtiar et al., 2018; Garrison, Anderson, & Archer, 2000; Gross, 1998; Isohätälä, Näykki, Järvelä, & Baker, 2018; Järvenoja & Järvelä, 2009; Lajoie et al., 2006, 2015, Näykki et al., 2017, 2014; Rogat & Linnenbrink-Garcia, 2011; Rourke, Anderson, Garrison, & Archer, 1999; Webster & Hadwin, 2015). Using the a priori coding scheme, the first author began coding both individual (solo) and group strategies. Codes were flexibly added, removed, or modified as necessary to reflect the data. One coding scheme was sufficient to cover both solo and group strategy descriptions. Saturation was met after 54% of the descriptions were coded and no modifications to the coding scheme were needed. At this point, a research assistant

was trained to use the coding scheme. Multiple codes were allowed because students often reported more than one strategy. Students' descriptions of their positive or negative experience were also reviewed to validate and clarify coding decisions. Strategies were randomly ordered, and the coders were blind to participant number, group number, assignment (first or second), and group planning condition. Two coders did three rounds of reliability coding to fine-tune the coding of approximately 20% of the data. The final round of reliability coding (20% of data) achieved a Krippendorff's alpha of .921 for solo strategies and .968 for group strategies. Table 1 contains the final set of codes with descriptions, examples, and overall frequencies of solo and group strategies. Uncodable strategies were excluded from subsequent analyses.

Frequencies of solo and group strategies. As can be seen in Table 1, the most frequently reported solo strategy was task focus (37%), whereas the most frequently reported group strategy was socio-emotional support (32%). In addition, relaxing was reported more frequently as a solo strategy (9% vs. 3%), whereas doing nothing was reported more frequently as a group strategy (9% vs. 1%).

Table 1

Codes, Descriptions, Examples, and Overall Frequencies of Solo and Group Strategies

Code	Description	Examples	Frequency (%)	
			Solo	Group
Task focus	Redirecting attention to the task; maintaining or increasing focus on the task or parts of the task; putting more effort into the task; doing one's best; calmly completing the task; offering to do more work.	*Solo:* I focused on the task at hand. *Group:* We all kept working hard to finish it and answer the questions to our best ability.	179 (37)	124 (27)
Socio-emotional support	Actions that are social in nature and contribute to a positive / productive group climate, such as encouraging participation, motivating others, checking in, providing positive feedback, accommodating needs (e.g., slowing down), actively communicating, and explaining an action that may be perceived negatively.	*Solo:* I asked questions as to how I and the rest of the group could help this group member solve her problem *Group:* They returned the compliments and made the overall atmosphere very pleasing	83 (17)	148 (32)
Co-constructing answers	Working together to answer questions by contributing to discussions, building on each other's ideas, and monitoring each other's work. Does not include dividing up the work or answering questions separately.	*Solo* When I felt this way, I managed to suggest a combination of our two answers as an alternative, as well ask the other group members what they thought. *Group:* we all worked together and came up with answers quickly as well as answered each question to the best of our ability	59 (12)	82 (18)
Regulating plans / approach	Understanding the task; making plans; monitoring progress; making changes to plans or approach.	*Solo:* I, along with my group decided we needed to make a change, which was completing a few questions individually. *Group:* They agreed on my proposed change in strategy and quickly distributed the work load and began formulating their answers.	30 (6)	29 (6)
Relaxing	Taking deep breaths; relaxing; calming down or remaining calm; calmly doing something.	*Solo:* I took a few minutes to calm down and focus on the task. *Group:* My group just remained calm and we just dealt with the challenge because they had to.	44 (9)	13 (3)

Doing nothing	Doing nothing or continuing the same previously ineffective action (e.g., asking the same question over and over). Also includes instances where students indicated their group was unaware of the event or their feelings.	*Solo:* nothing, I was feeling good *Group:* We were all stressed for time so it was difficult to act on it as we were all in the same frenzy.	6 (1)	41 (9)
Positive thinking / changing thoughts	Thinking positively; motivating oneself; changing one's own thinking or beliefs about the task. This code is reserved for internal positive thinking, not positive actions shared among the group (coded as socio-emotional support instead).	*Solo:* I told myself don't be nervous, I could do better on the next question *Group:* N/A	42 (9)	N/A
Expressing concerns / help-seeking	Expressing or communicating concerns, challenges, and/or negative feelings; asking for help.	*Solo:* I tried to communicate with the group that I was struggling *Group:* The editor verbalized her similar [negative] feelings.	20 (4)	4 (1)
Discouraging participation / disengaging	Discouraging participation or undermining task contributions by criticizing another's work, ignoring feedback or questions, or rejecting contributions. Also includes undermining one's own or the group's abilities (low efficacy) and avoiding commitment to the task or reducing engagement.	*Solo:* my contribution lacked during this time *Group:* Kept coming with other suggestions or talked about them, not really giving me an answer on my question.	4 (1)	11 (2)
Compensating	Compensating for another member's low participation or absence from the task; taking over someone's part when they encounter difficulties.	*Solo:* Try to take over some of the work that the other person was supposed to do. *Group:* my group was confused and one member was absent from contributing their information to the challenge so we had to pick up her slack.	8 (2)	7 (2)
Censoring or suppressing	Not sharing emotions or concerns with the group; ignoring the emotion.	*Solo:* I kept it in and kept going, in my attempt to not let it effect the group work *Group:* We put the negative feelings behind us and moved forward to get past this challenge	9 (2)	1 (<1)
Uncodable	Statements that are unclear or do not answer the question in the expected way.		6 (1)	3 (1)
Total			490	463

Note. Strategies are listed in descending order of overall frequency across solo and group strategies.

Table 2 lists the most frequently reported solo and group strategies when broken down by positive versus negative emotions (see Appendix A for percentage of all strategies within and across assignments). Aside from task focus, the top solo strategies for regulating positive and negative emotions differed. Socio-emotional support, co-constructing answers, and positive thinking / changing thoughts were reported more frequently for positive emotions, whereas relaxing and regulating plans / approach were reported more frequently for negative emotions. Regarding group strategies, students most frequently reported socio-emotional support, task focus, and co-constructing answers for positive emotions. In contrast, students reported more variety when regulating negative emotions. In addition to the three strategies for positive emotions, they also reported doing nothing and regulating plans / approach. Overall, these findings suggest students varied their strategy use depending on the level of strategy (solo vs. group) and the valence of their emotions (positive vs. negative).

Mode of group emotion regulation. For both positive and negative emotions, students most frequently reported enacting the group strategy together with their group (Figure 4). However, the proportion of students reporting shared enactment was greater for positive than negative emotions in both assignments. When faced with negative emotions, a greater proportion of students reported other group members enacted the strategy or their group did nothing. At both times, the difference in frequencies were statistically detectable (Assignment 1, $\chi^2 = 10.27$, $p = .016$; Assignment 2, $\chi^2 = 29.52$, $p < .001$).

Table 2

Percentage of Overall Solo and Group Strategies Reported for Positive and Negative Emotions

Strategy level	Positive emotion (f = 280)	Negative emotion (f = 201)
Solo	1. Task focus (41%) 2. Socio-emotional support (23%) 3. Co-constructing answers (15%) 4. Positive thinking / changing thoughts (12%)	1. Task focus (31%) 2. Relaxing (16%) 3. Regulating plans / approach (11%)
	Positive emotion (f = 278)	Negative emotion (f = 179)
Group	1. Socio-emotional support (38%) 2. Task focus (31%) 3. Co-constructing answers (23%)	1. Socio-emotional support (23%) 2. Task focus (21%) 3. Doing nothing (20%) 4. Regulating plans / approach (11%) 5. Co-constructing answers (11%)

Note. Solo and group strategies comprising 10% or more of the total frequency reported for positive and negative emotions are listed.

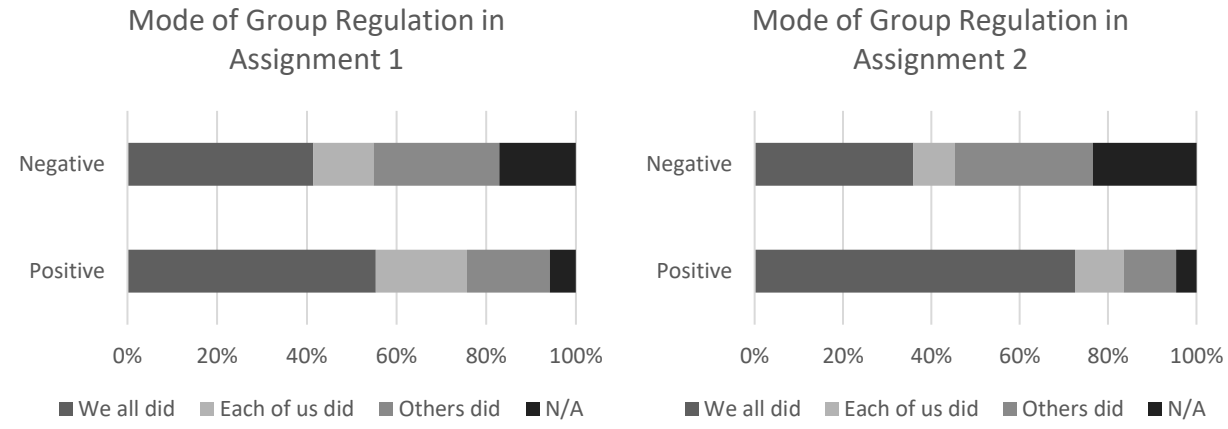


Figure 4. Proportion of students reporting each mode of group regulation for positive and negative emotions in Assignment 1 (left graph) and Assignment 2 (right graph). N/A = my group didn't do anything.

How Effective Were Solo and Group Strategies for Regulating Emotions and Facilitating Progress?

Students' evaluations of their solo and group strategies were examined in terms of self-reported (a) helpfulness for regulating positive versus negative emotions and (b) effectiveness for facilitating progress. We did not examine evaluations of specific strategy categories identified in the previous analysis because students only provided one evaluation regardless of the number of coded strategies in their strategy descriptions. That is, we were unable to attain independent ratings for each specific strategy students described, so we examined their evaluations at the broader solo and group levels.

Tables 3 and 4 summarize students' evaluations of their solo and group strategies for positive and negative emotions in terms of (a) the proportion of students who reported the strategy was helpful for regulating their emotion (Table 3) and (b) mean ratings of strategy effectiveness for facilitating progress (Table 4). Overall, students evaluated their strategies as helpful and effective. Analysis revealed three patterns:

1. Both solo and group strategies were more highly evaluated for regulating emotions and facilitating progress when students reported a positive emotion.
2. Solo strategies were reported to be more helpful than group strategies for regulating negative emotions, which was confirmed by McNemar's Chi-Square Test for Assignment 1, $\chi^2 = 10.23$, = .001 and Assignment 2, $\chi^2 = 4.5$, $p = .034$.
3. Group strategies were generally rated as more effective for progress than solo strategies, except when students reported a negative emotion in the first assignment.

Findings indicate the perceived effectiveness of strategies varied depending on (a) the valence of emotion (positive vs. negative), (b) the level of strategy (solo vs. group), and (c) the source of evaluation (helpfulness for emotion vs. effectiveness for progress).

Table 3

Percentage of Students Reporting Their Strategies Were Helpful for Regulating Positive and Negative Emotions

	Assignment 1		Assignment 2	
Strategy level	Positive (n = 103)	Negative (n = 82[a])	Positive (n = 109)	Negative (n = 64)
Solo	99	87	97	84
Group	97	67	98	69

[a]For group strategy, n = 81.

Table 4

Mean (SD) Ratings of Strategy Effectiveness for Facilitating Progress When Regulating Positive and Negative Emotions

	Assignment 1		Assignment 2	
Strategy level	Positive (n = 103)	Negative (n = 82)	Positive (n = 109)	Negative (n = 64)
Solo	1.16 (0.78)	0.70 (1.05)	1.36 (0.76)	0.75 (1.01)
Group	1.51 (0.65)	0.44 (1.31)	1.53 (0.65)	0.86 (1.01)

Note. Scores could range from -2 (*a lot harder*) to 2 (*a lot easier*).

Did Reports of Emotions and Emotion Regulation Strategies Differ Under Three Types of Group Planning Support?

Students' self-reported emotions, strategies, and evaluations differed among planning visualization conditions, although not always as expected. Overall, students in the no visualization condition demonstrated a positive shift in their emotions and strategy evaluations from one assignment to the next.

Frequencies of positive and negative emotions. Students in all three planning support conditions reported more positive than negative emotions during Assignments 1 and 2. In Assignment 1, a higher proportion of students in the nominal planning support condition reported a positive emotion (64%) compared to the quantified condition (53%) and the no visualization condition (54%), but this difference was not statistically detectable, $\chi^2 = 2.70$, $p = .26$. However, in Assignment 2, a higher proportion of students in the no visualization condition (76%) reported a positive emotion compared to the quantified condition (55%) and the nominal condition (56%), $\chi^2 = 8.13$, $p = .02$. Our hypothesis that students who receive less planning support will report more negative emotions was not supported by these findings.

Frequencies of solo and group strategies. Table 5 lists the most frequently reported solo and group strategies in each condition overall (see Appendix B for frequencies of all strategies, broken down by assignment). In general, the most frequently reported strategies were similar across conditions; however, *regulating plans or approach* was a more frequently reported solo and group strategy for students who received quantified planning support compared to other types of planning support.

Table 5

Percentage of Overall Solo and Group Strategies Reported in Each Planning Condition

Strategy level	Quantified (*f* = 153)	Nominal (*f* = 173)	No visualization (*f* = 131)
Solo	1. Task focus (35%) 2. Socio-emotional support (16%) 3. Regulating plans / approach (12%) 4. Co-constructing answers (10%) 5. Relaxing (10%)	1. Task focus (40%) 2. Socio-emotional support (15%) 3. Co-constructing answers (15%) 4. Positive thinking / changing thoughts (11%)	1. Task focus (37%) 2. Socio-emotional support (22%) 3. Co-constructing answers (12%)

	Quantified (f = 135)	Nominal (f = 164)	No visualization (f = 133)
Group	1. Task focus (30%) 2. Socio-emotional support (24%) 3. Co-constructing answers (17%) 4. Regulating plans / approach (13%)	1. Socio-emotional support (36%) 2. Task focus (25%) 3. Co-constructing answers (19%) 4. Doing nothing (10%)	1. Socio-emotional support (37%) 2. Task focus (28%) 3. Co-constructing answers (17%) 4. Doing nothing (11%)

Note. Solo and group strategies comprising 10% or more of the total frequency reported in each planning condition are listed.

Effectiveness of strategies. Table 6 displays the proportion of students in each planning condition who indicated the strategies were helpful for regulating their emotion. The majority of students viewed both solo and group strategies as helpful for regulating their emotions, regardless of planning support condition. However, more students who received less planning support (no visualization condition) reported their group strategy was helpful in Assignment 2 (94%) compared to Assignment 1 (80%), whereas students who received more planning support (nominal or quantified visualization) reported similar proportions of helpfulness across the two assignments (84-85%).

Table 7 displays the mean ratings of strategy effectiveness (on a scale from -2 to 2) for facilitating task completion in each condition. In Assignment 1, students who received minimal planning support (no visualization condition) evaluated (a) solo strategies as less effective (M = 0.91) than students who received planning support in the form of nominal visualizations (M = 1.01) and (b) group strategies as less effective (M = 0.81) than students who received planning support in the quantified condition (M = 0.96) and the nominal condition (M = 1.24). Findings support the hypothesis that students with less planning support report lower success with their strategies. However, this was only the case for the first time they collaborated together

(Assignment 1). By Assignment 2, students who received no planning visualization support rated their strategies as more effective than students who received either kind of planning visualization support (nominal or quantified). A two-way mixed ANOVA for group (but not solo) strategies revealed a statistically detectable main effect of time, $F(1, 161) = 9.10$, $p = .003$, and a statistically detectable interaction of time and condition, $F(2, 161) = 4.48$, $p = .013$, suggesting there was a greater increase in strategy effectiveness over time for students receiving less support.

Table 6

Percentage of Students in Each Planning Condition Reporting Their Strategies Were Helpful for Regulating Emotions

	Assignment 1			Assignment 2		
Strategy level	Quantified (n = 52)	Nominal (n = 67)	No visualization (n = 57[a])	Quantified (n = 50)	Nominal (n = 62)	No visualization (n = 52)
Solo	92	96	93	88	94	94
Group	85	84	80	84	84	94

[a]For group strategy, n = 56.

Table 7

Mean (SD) Ratings of Strategy Effectiveness for Facilitating Progress in Each Planning Condition

	Assignment 1			Assignment 2		
Strategy level	Quantified (n = 52)	Nominal (n = 67)	No visualization (n = 57)	Quantified (n = 50)	Nominal (n = 62)	No visualization (n = 52)
Solo	0.90 (1.01)	1.01 (0.88)	0.91 (0.95)	1.02 (0.89)	1.06 (0.99)	1.23 (0.83)
Group	0.96 (1.08)	1.24 (1.07)	0.81 (1.25)	1.22 (0.86)	1.19 (0.97)	1.42 (0.70)

Note. Scores could range from -2 (*a lot harder*) to 2 (*a lot easier*).

Mode of group regulation. A higher proportion of students indicated the emotion regulation strategy they reported was something they all did together. This was true regardless of whether it was the first or second time collaborating together (Assignment 1 and 2) or the kind of planning visualization support they received (no visualization, nominal, or quantified; see Figure 5). The highest degree of variability in reporting emotion regulation as a shared process emerged for Assignment 1, where higher proportions of students receiving (a) no planning visualization support reported emotion regulation strategies as shared amongst group members (i.e., we all did together), (b) quantified planning visualizations reported emotion regulation as something each person in the group took responsibility for (i.e., each of us did), and (c) nominal planning visualizations reported emotion regulation as the responsibility of other people in their group (i.e., other members did). These differences were statistically detectable for the first collaborative project (Assignment 1), $\chi^2 = 17.51$, $p = .008$, but not the second (Assignment 2), $\chi^2 = 3.34$, $p = .76$.

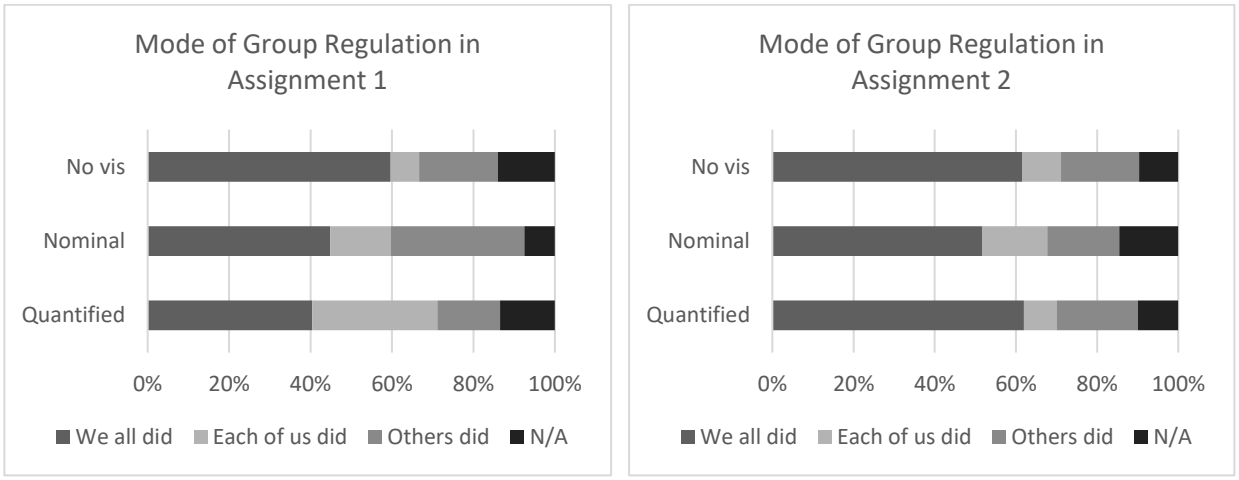


Figure 5. Proportion of students in each planning condition reporting each mode of group regulation for Assignment 1 (left graph) and Assignment 2 (right graph). Quant = quantified; No vis = no visualization; N/A = my group didn't do anything.

Discussion

The findings from this study add to the literature on emotion regulation in CSCL contexts in five ways. First, this study is one of a very limited number of studies to identify specific strategies students use to regulate their emotions during online collaboration. Second, this study catalogued emotion regulation strategies deployed both individually as well as by groups, thereby contributing to conceptualizations of emotions as something both teams and individuals regulate during collaboration (Hadwin, Järvelä, et al., 2018; Järvelä et al., 2016). Students described similar actions for solo and group strategies, with the top strategies for both levels of regulation including focusing on the task, providing socio-emotional support, and co-constructing answers. Given the time-limited nature of the collaborative problem-solving task, it is not surprising these strategies centred around getting the task done and contributing to a positive environment. Future research may wish to examine the types of strategies students use under different collaborative contexts, such as a project that is completed over multiple sessions.

Third, this study allowed for coding multiple types of strategies emerging in students' open descriptions of emotion regulation strategies. Aldao and Nolen-Hoeksema (2013) point out that research often oversimplifies the emotion regulation process by assuming individuals only use one emotion regulation strategy. Our study supports their findings that individuals often report using more than one strategy to address salient challenges arising during collaboration. Aldao and Nolen-Hoeksema (2013) also found that individuals who reported using only one strategy tended to use it to a greater extent and reported lower levels of disgust (the target emotion) compared to individuals who reported using multiple strategies. However, as the authors point out, participants reported their emotions throughout the stimulus event, but reported their use of strategies retrospectively after the event. Thus, their findings do not provide

evidence of a causal relation between the use of one versus multiple strategies and the level of disgust experienced. Future research could further investigate the efficacy of using one versus multiple strategies by gathering data during the event about strategy use and subsequent effectiveness of those strategies for regulating emotions.

Fourth, this study contributes to research by evidencing that students actively regulate both positive and negative emotions during online teamwork. Change and adaptation in the face of challenge is a significant feature of regulated learning (Hadwin et al., 2017) and drives valuable research in the area of emotion regulation (e.g., Järvelä & Järvenoja, 2011; Järvenoja et al., 2013; Webster & Hadwin, 2015). However, this study suggests students may benefit not only from regulating difficult emotions but also from regulating positive emotions (Tugade & Fredrickson, 2006). According to Fredrickson's (1998; Fredrickson & Cohn, 2008) broaden-and-build theory, positive emotions promote creative and flexible thinking. In the context of collaboration, maintaining or increasing positive emotions may also contribute to a positive socio-emotional climate (Bakhtiar et al., 2018). In addition, reflecting on successful experiences may provide valuable information for students as they move forward to the next task, supporting students to avoid or mitigate potential future challenges.

Finally, this study contributes to research and practice by leveraging two CSCL regulation tools—one for planning and one for reflecting—and examining how they interact. The group planning tool was designed to enhance metacognitive awareness of group members' individual planning ideas through the use of visualizations, with the intent to stimulate negotiation and co-construction of a group plan. The Socio-Emotional Reflection Tool (SERT) served dual purposes: (a) stimulating metacognitive awareness and reflection (Järvelä et al., 2015) and (b) collecting data about students' emotion regulation experiences. On its own, the

SERT provided valuable data about students' emotional experiences for research purposes and for guiding students' subsequent actions in their next collaborative task. However, this study allowed for further examination of students' reflections in light of the type of group planning support they received. Findings indicate different types of group planning support may differentially relate to students' emotional experiences, discussed in more detail later.

Strategy Use and Effectiveness Vary by Strategy Level and Emotion Valence

Examination of the frequencies and self-evaluations of strategies revealed some variations in terms of both the source of who deployed strategies (individuals or groups) and the valence (positive or negative) of emotions experienced during collaboration. Students reported task focus most frequently as a strategy deployed individually (solo strategy), whereas they reported socio-emotional support most frequently as a strategy deployed by group members (group strategy). In addition, when individually regulating positive emotions, students more frequently reported providing socio-emotional support, co-constructing answers, and positive thinking / changing thoughts. When individually regulating negative emotions, they more frequently reported relaxing and regulating plans / approach. Finally, the most frequently reported group strategies were similar for positive and negative emotions (i.e., socio-emotional support, task focus, and co-constructing answers), but students reported doing nothing and regulating plans / approach more frequently for negative emotions than for positive emotions. Together these findings indicate that emotion regulation is a context and situation-specific process (Diamond & Aspinwall, 2003; Koole, 2009). Rather than relying on one primary strategy in all situations, students report deploying strategies dependent upon the type of emotion they experience and whether it was an individual or group effort.

Furthermore, even the reported effectiveness of strategies differed according to the types of emotions that were experienced. Emotion regulation strategies deployed by individuals (solo strategies) were more frequently reported as helpful for regulating negative versus positive emotions, whereas strategies deployed by the group (group strategies) were rated as more effective for completing the task. These findings provide empirical support for theoretical claims that both individuals and groups must adaptively deploy emotion regulation strategies that are suited to the challenges and situations that arise during group work (Hadwin et al., 2017; Järvenoja & Järvelä, 2009; Panadero et al., 2015).

Strategies for regulating positive emotions were evaluated as more helpful for regulating emotions and more effective for facilitating task completion than strategies for regulating negative emotions. If students' positive emotions reflected positive appraisals of the situation, then it is not surprising they would perceive their actions in those situations to be more effective. This discrepancy in strategy evaluations does not suggest regulating negative emotions is less important. When groups experience challenges, resulting in persistent or intense negative emotional responses, taking action to address and resolve the problem seems crucial. Without regulatory action, progress may be drastically impeded. Indeed, evaluations of strategies in the context of negative emotions were still favorable, even if not as favorable as for positive emotions.

Planning Support May Alter Students' Emotional Experiences During Collaboration

Findings from this study suggest planning support may have an effect on students' emotional experiences during collaboration but that effect might differ depending on whether teams are collaborating for the first time or have already gained some experience working together. For the first CSCL task (Assignment 1) students worked in groups for the first time. In

this context, students who received no planning visualization support were similar to students who received planning visualization support (nominal or quantified) in terms of reporting positive emotions and evaluating their strategies as effective for regulating emotions and facilitating progress. However, students in groups with no visualization planning support were more likely to report enacting emotion regulation strategies together as a group. Although this latter finding was unexpected, a possible explanation is that receiving less support during group planning meant students had to work more closely together as a group to regulate the challenges they encountered.

Once students had some experience collaborating with each other (Assignment 2), the biggest changes from the first collaboration (Assignment 1) to the second (Assignment 2) were observed for students who received less planning support (no visualization). In particular, these students were more likely to report positive emotions, evaluate their group strategies as helpful for regulating emotions, and rate their group strategies as more effective for facilitating task completion. One explanation for the overall change is these students learned from their experiences and challenges in the first assignment, which stimulated better preparation for the second assignment. Past research with the same sample of students indicated those who received no visualization support in the first assignment reported (a) more severe planning challenges, which positively correlated with severity of other challenges (i.e., doing the task, checking progress, and groupwork) and (b) less success overall with their strategies targeting those challenges (Hadwin, Bakhtiar, et al., 2018). Encountering more challenges in the first assignment may have prompted students to improve their planning for the second assignment, resulting in a greater positive experience. Another explanation is these students engaged in lower quality planning discussions leading to lower metacognitive awareness of actual progress, ultimately

resulting in higher positive appraisals of their experience than might be warranted. If this was the case, however, one might expect to find their evaluations were higher relative to students in the other planning visualization conditions in the first assignment as well. This finding is something to follow up with future research to better understand the pattern observed across data sources.

Limitations

An important component of regulated learning is the intentionality of learners to take action in response to a situation or challenge (Hadwin et al., 2017). Participants in this study did not report on the intentionality of their actions, thus, we cannot claim that students were purposefully regulating their emotions in the moment. In some cases, it is possible students were reflecting upon behaviours designed to achieve goals not directly about their emotions. For example, focusing on the task and co-constructing answers may have been actions students took without intending to regulate their emotions, but upon reflection, students perceived an effect on their emotions. Despite this possibility, our findings can benefit practice and further research in this area. For example, CSCL tools that script emotion regulation in the moment (such as the Socio-Emotional Sampling Tool; Webster & Hadwin, 2014) could incorporate some of the actions identified in this study, such as co-constructing answers, to capture students' intentions to regulate their emotions using these strategies.

Emotions were grouped according to their valence (positive or negative) for analysis in this study, but we acknowledge negative emotions may be perceived as desirable and positive emotions may be perceived as undesirable by different people and in different situations (e.g., Eid & Diener, 2001). For example, anxiety is typically considered a negative emotion, but a student may evaluate this emotion as desirable if it motivates greater focus on the task (Pekrun, 2016). Winne and Hadwin's (1998, 2008) model of SRL emphasizes students' evaluations

prompt regulatory action. From this perspective, students set goals and select strategies for regulating emotions depending on how they evaluate those emotions rather than the valence of the emotion as positive or negative. In this study, the SERT did not prompt students to evaluate their emotions. Findings may have differed if strategies were examined in the context of students' evaluations.

The strategies in this study were self-reported by individual group members after the task. As a result, their descriptions may not accurately reflect what happened during the task (Winne & Jamieson-Noel, 2002). Future research should examine evidence of group strategies and/or alignment among group members' reports to corroborate self-reports. In this study, because students could choose to report on any experience during the collaborative session, it would have been challenging to look for evidence or alignment as we did not necessarily know which point in the session they were referring to or if the group was describing the same event. In the future, students could be directed to report on the same situation.

To further reduce bias or error in students' memory and evaluations of their strategies, it would be helpful to collect data about their experiences in situ. For example, the Socio-Emotional Sampling Tool (SEST; Webster & Hadwin, 2014) prompts individuals to identify a salient emotion in the moment and, if desired, create a plan to regulate that emotion. The SEST could be modified to include follow-up questions about the use and effectiveness of the strategies they planned to enact. At a group level, Järvelä and colleagues (Järvenoja et al., 2017; Näykki et al., 2017) have used scripting and awareness tools during face-to-face group work to prompt groups to monitor their progress, plan for strategy use, and reflect on and evaluate their work. Similar methods could be employed for online groups to capture more accurate information about group-level strategy use and evaluations.

Finally, because students were able to report multiple actions for regulating their emotions in one description, we could not easily compare the effectiveness of individual strategies. To address this issue, tools used to capture students' evaluations could include a list of strategies and ask students to separately rate each strategy they used.

Conclusion

This study contributes to the literature on emotion regulation in collaborative contexts by describing the specific actions students take in response to salient emotions they experience. This provides a starting point for developing an inventory of strategies that may support students to more productively regulate during group work. Future research can investigate the effectiveness of interventions that draw on this inventory of strategies. Findings from this study also provide insight into the relation between emotion regulation and planning, a core feature of regulated learning. Although groups were not prompted to plan specifically in regards to socio-emotional aspects of collaboration, it appears different types of planning support in the form of visualizations may have an effect on emotional processes. Of interest, students who received less planning support (i.e., no visualizations) demonstrated a greater positive shift from one task to the next in terms of reporting more positive emotions and higher evaluations of their emotion regulation strategies compared to students who received more planning support (i.e., quantified or nominal visualizations). This points to the importance of examining regulatory processes over time to better understand the cyclical nature of regulation.

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Appendix A

Percentage of Solo Strategies (Top) and Group Strategies (Bottom) for Regulating Positive and Negative Emotions

	Assignment 1		Assignment 2		Overall	
Strategy	**Positive**	**Negative**	**Positive**	**Negative**	**Positive**	**Negative**
			Solo			
Task focus	38	35	44	26	41	31
Socio-emotional support	21	8	24	11	23	9
Co-constructing answers	17	8	13	9	15	8
Relaxing	4	15	4	19	4	16
Positive thinking / changing thoughts	15	3	9	7	12	4
Regulating plans / approach	1	13	3	10	2	11
Expressing concerns / help-seeking	3	5	0	12	1	8
Censoring or suppressing	0	5	0	3	0	4
Compensating	1	6	0	0	<1	3
Doing nothing	0	0	4	1	2	<1
Discouraging participation / disengaging	0	2	0	2	0	2
Total frequency	142	110	138	91	280	201
			Group			
Socio-emotional support	37	19	38	28	38	23
Task focus	29	24	33	17	31	21
Co-constructing answers	24	9	22	12	23	11
Doing nothing	1	20	3	19	2	20
Regulating plans / approach	5	13	1	9	3	11

Relaxing	4	3	2	2	3	3
Discouraging participation / disengaging	0	5	0	6	0	6
Compensating	1	4	0	1	<1	3
Expressing concerns / help-seeking	0	0	0	5	0	2
Censoring or suppressing	0	1	0	0	0	1
Total frequency	140	98	138	81	278	179

Note. Strategies listed in descending order of overall frequency across positive and negative emotions.

Appendix B

Percentage of Solo Strategies (Top) and Group Strategies (Bottom) in Each Condition

	Quantified		Nominal		No visualization	
	Assignment 1	**Assignment 2**	**Assignment 1**	**Assignment 2**	**Assignment 1**	**Assignment 2**
			Solo			
Task focus	29	41	41	40	41	31
Socio-emotional support	19	12	13	17	16	30
Co-constructing answers	10	11	19	11	11	13
Relaxing	8	12	6	11	11	3
Positive thinking / changing thoughts	8	7	11	11	7	7
Regulating plans / approach	13	11	1	4	4	3
Expressing concerns / help-seeking	3	4	4	4	4	5
Censoring / suppressing	4	1	2	1	1	2
Compensating	6	0	1	0	3	0
Doing nothing	0	1	0	0	0	7
Discouraging participation / disengaging	1	0	1	2	0	0
Total frequency	79	74	90	83	70	61

			Group			
Socio-emotional support	21	26	34	38	35	39
Task focus	30	30	25	25	26	30
Co-constructing answers	15	19	20	18	17	16
Doing nothing	8	7	8	12	14	7
Regulating plans / approach	18	9	5	1	3	2
Relaxing	2	1	5	4	1	0
Discouraging participation / disengaging	2	1	3	3	1	3
Compensating	3	1	0	0	3	2
Expressing concerns / help-seeking	0	4	0	0	0	2
Censoring / suppressing	2	0	0	0	0	0
Total	66	69	87	77	72	61

Note. Strategies listed in descending order of overall frequency across conditions and assignments.

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Planning and Emotion Regulation During Two Online Collaborative Tasks

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Abstract

This study examined the link between levels of planning and preparation prior to a computer-supported collaborative learning (CSCL) task and patterns of emotion regulation during that task and a subsequent CSCL task. Participants were students enrolled in an undergraduate learning-to-learn course. Students worked in groups of three to five to complete two CSCL tasks. Findings from the first task indicated students who were underprepared in terms of (a) weak task understanding, (b) late submission of individual preparation activities, and (c) minimal contributions to group planning, entered the task feeling more positive than students who were well-prepared. Patterns of emotions over time indicated underprepared students consistently reported more positive than negative emotions, whereas well-prepared students were more variable in their reports. Patterns changed for well-prepared, but not underprepared, students from their first collaboration experience to their second. One explanation of these findings is that well-prepared students may be more metacognitively aware of their emotions and more adaptive compared to underprepared students.

Keywords: emotions; emotion regulation; planning; computer-supported collaborative learning

Planning and Emotion Regulation During Two Online Collaborative Tasks

Theory and research emphasize the importance of planning in self-regulated learning (SRL; Greene, Hutchison, Costa, & Crompton, 2012; Winne & Hadwin, 1998, 2008) and both solo and group planning for regulating learning in collaborative tasks (Hadwin, Järvelä, & Miller, 2018). An under-explored area of research in collaborative contexts is the regulation of emotions and, specifically, how planning and preparation prior to the task might contribute to group members' emotions and competency to manage emotions during the task. Prior research has provided evidence for the importance of group members' self-regulation of learning in promoting shared regulatory processes and a positive collaborative experience (Bakhtiar, Webster, & Hadwin, 2018; Panadero, Kirschner, Järvelä, Malmberg, & Järvenoja, 2015), suggesting that entering a collaborative task well prepared is an important factor in adaptively regulating during the task.

Regulating Learning in Collaboration

Hadwin et al. (2018) posit that successful collaboration involves three modes of regulation: self-regulated learning (SRL), socially-shared regulation of learning (SSRL), and co-regulated learning (CoRL). SRL refers to goal-directed, strategic, and metacognitive engagement in learning; it involves monitoring, evaluating, and adapting cognitions, behaviors, motivation, and affect to accomplish personal goals (Pintrich, 2000; Zimmerman, 1989, 1990). In the context of collaboration, SRL refers to individual group members regulating their own learning in the interest of shared group outcomes. SSRL refers to group members regulating together towards shared outcomes, and CoRL refers to temporarily supporting or constraining regulatory processes of one or more group members (Hadwin et al., 2018).

Winne and Hadwin's (1998, 2008) model of SRL provides a good framework for examining self-, co-, and shared regulatory processes. Their model describes learning as a weakly sequenced, recursive process of (a) developing task perceptions, (b) creating task-specific goals and plans, (c) strategically selecting and enacting tactics to achieve goals, and (d) adapting as needed within and across tasks. Planning comprises the first two phases of this model, with task perceptions informing the goals students set and the plans they make. These foundational phases direct task enactment in the third phase and enable students to metacognitively monitor and evaluate their progress, which is critical for making changes both within and across tasks in the last phase. Importantly, if students have inaccurate or incomplete understanding of the task, it can be detrimental to subsequent regulation leading students to direct their efforts towards misguided goals and standards (Hadwin & Winne, 2012). Thus, being adequately prepared for a task is vital for efficiently and effectively engaging in that task.

Five facets underlie each phase of the cycle, denoted by the acronym COPES (Winne & Hadwin, 1998, 2008): conditions, operations, products, evaluations, and standards. Internal and external *conditions* provide a context for engagement in each phase. Internal conditions are comprised of factors internal to the student, such as prior knowledge, motivation, and emotions; external conditions are comprised of factors external to the student, such as task demands, resources available, and time constraints. Students cognitively process or manipulate information through *operations*, resulting in *products* in each phase, which may in turn become conditions for the next phase. Finally, students make *evaluations* of the products by comparing them to *standards*.

The Role of Emotions in COPES

In the COPES framework, emotions are considered both conditions and products. For instance, as a condition, a student's feeling of anxiety might interfere with the ability to focus on answering a question in an assignment. Failing to answer the question might result in more anxiety (a product). Although the distinction between emotions as conditions or products is not always apparent, theory and research indicate emotions play an important role in group work through connections with other important group constructs, such as socio-emotional interactions and social-behavioral engagement (Bakhtiar et al., 2018; Duffy & Shaw, 2000; Linnenbrink-Garcia, Rogat, & Koskey, 2011), conflict management (Jehn, 1997), and trust and cohesion (Dunn & Schweitzer, 2005; Jones & George, 1998; Wegerif, 1998).

Emotion Regulation in Collaboration

When students perceive the need to alter or maintain their feelings, emotions become a target for regulation (Winne & Hadwin, 2008). From this perspective, regulating emotions involves (a) being aware of and understanding emotions, (b) setting goals and devising plans for influencing the type, timing, and/or intensity of emotions (Gross, 1998, 1999; Koole, 2009; Thompson, 1994), (c) enacting strategies for achieving goals, and (d) monitoring, evaluating, and adapting the approach when the need arises.

In collaborative learning contexts, these processes should occur at both the individual and group level (Järvenoja & Järvelä, 2009). That is, successful regulation of emotions in collaboration may require (a) individuals regulating their own emotional states (SRL), (b) group members prompting fellow group members to regulate their emotional states (CoRL), and (c) groups sharing in the regulation of emotional states (SSRL; Hadwin et al., 2018).

Research examining emotion regulation in collaborative learning contexts is growing (e.g., Ayoko, Konrad, & Boyle, 2012; Bakhtiar et al., 2018; Järvenoja & Järvelä, 2009; Järvenoja, Järvelä, & Malmberg, 2017; Lajoie et al., 2015; Näykki, Järvelä, Kirschner, & Järvenoja, 2014; Xu, Du, & Fan, 2013, 2014). However, few studies have examined the importance of planning and preparation prior to the collaborative task in relation to emotions experienced during the collaboration. In a previous case study, we found that a group containing members who were overall better prepared for a collaborative task were more successful in creating a positive socio-emotional climate than a group containing members who were overall less prepared (Bakhtiar et al., 2018). To follow up our previous study, we employed purposive sampling to more closely examine and compare emotion regulation patterns of students in groups that enter a collaborative task relatively well-prepared versus underprepared.

Adaptive Patterns of Emotion Regulation

Past research findings indicate positive emotional states are associated with beneficial processes and outcomes in group work, whereas strong negative emotional states are associated with detrimental effects (e.g., Barsade & Gibson, 2007; Duffy & Shaw, 2000; Jehn, 1997; Rogat & Linnenbrink-Garcia, 2011; Salonen, Vauras, & Efklides, 2005; Volet, Summers, & Thurman, 2009). These findings suggest that adaptive patterns of regulation would involve maintaining or increasing positive emotions and/or decreasing negative emotions. However, there is an argument by some organizational researchers (e.g., Phillips & Lount, Jr, 2007; Rhee, 2007) that negative emotions in a group may actually be beneficial in problem-solving or decision-making tasks as opposed to creative tasks. Furthermore, George and King (2007) posit that heterogeneity in mood states might be advantageous in complex tasks where having multiple-shared realities—rather than a single-shared reality—better reflects the uncertainty and ambiguity of the task.

Groups may benefit from the diverse contributions made by members in positive moods (e.g., creative thinking, confidence) and members in negative moods (e.g., analytical thinking, attempts to improve the situation). This highlights the importance of taking context into account when examining adaptive patterns of emotion regulation.

Research on emotion regulation strategies provides evidence of the efficacy of specific types of strategies. For example, strategies in the form of reappraisal or focusing on the problem/task are generally found to be more effective than strategies in the form of focusing on or attempting to suppress the emotion (Davis, DiStefano, & Schutz, 2008; Gross & John, 2003; MacCann, Fogarty, Zeidner, & Roberts, 2011; Srivastava, Tamir, McGonigal, John, & Gross, 2009). In contrast, Wagstaff and Weston (2014) found that strategies considered maladaptive, including suppression, were perceived as effective as or more effective than adaptive strategies, such as positive reappraisal, during a 2-month team expedition in the Antarctic. This finding demonstrates that what is adaptive for one person in one context may be maladaptive for another person or in a different context (Folkman & Moskowitz, 2004; Koole, 2009). Adaptive patterns of regulation in collaboration may therefore look different depending on the context and goals of the group members. Indeed, in Winne and Hadwin's (1998, 2008) model, evaluations of products against standards are key for making changes to studying. Thus, students' judgments of their emotions and the effectiveness of their strategies are also important to consider in adaptive regulation.

Purpose

This study aims to examine the link between planning and preparation prior to collaboration and patterns of emotion regulation during collaboration. Our primary research question was: what patterns of emotion regulation do underprepared versus well-prepared

students demonstrate during a CSCL task and a follow-up CSCL task? To address this question, we analyzed data generated by these students about their emotions and plans for emotion regulation during each task as well as their emotions and strategies for regulating those emotions retrospectively reported after each task.

We hypothesized students entering the first task well-prepared would demonstrate adaptive patterns of emotion regulation during the task and from one task to the next. Adaptive patterns were conceptualized as positive change in emotions and evaluations of emotion regulation strategy effectiveness. In contrast, we hypothesized students who were underprepared would show less adaptive patterns of emotion regulation because they were less equipped to avoid or address challenges during the task. For instance, these students might report more negative emotions and demonstrate less positive change in their emotions and evaluations of emotion regulation strategy effectiveness.

We did not make any hypotheses about the specific types of emotion regulation strategies students planned to use or reported using to regulate their emotions because there is little prior research on specific strategies that may be more or less adaptive in CSCL contexts. However, we hypothesized that underprepared students would (a) encounter more challenges requiring a different set of strategies than well-prepared students and (b) rely more on their groupmates to help them regulate when they encountered challenges.

Methods

Participants and Purposive Sampling Strategy

Participants included 27 underprepared and 32 well-prepared students enrolled in an undergraduate learning-to-learn course. This graded elective course introduced theory and research about learning, motivation and self-regulated learning, and required students to apply

course concepts to their own undergraduate studying and learning experiences. Underprepared and well-prepared students were selected from 189 consenting students on the basis of two indicators of planning and preparation for the first of two CSCL tasks (described in the next section): (a) solo preparation and (b) contribution to group planning. Students received a score out of 2 for solo preparation, consisting of a task understanding accuracy score out of 1 and a personal responsibility score out of 1 (see Measures for further information). Contributions to group planning were determined by number of words contributed to the group planning chat and/or wiki. Students classified as underprepared (n = 27) were those who (a) scored below the mean on solo preparation and (b) contributed minimally to group planning (score of 0). Students classified as well-prepared (n = 32) were those who (a) scored above the mean on solo preparation and (b) contributed substantially to group planning (score of 1). Table 1 contains means and SDs for each indicator for all students and each subsample.

Table 1

Means (SDs) of Planning and Preparation Indicators in All Students and Each Subsample

	All students	Underprepared students	Well-prepared students
Solo preparation score (out of 2)	1.47 (0.35)	1.10 (0.24)	1.78 (0.10)
Words contributed to group chat	238.36 (253.63)	59.96 (36.65)	463.72 (310.35)

Table 2 contains demographic information for all students and each subsample. Compared to well-prepared students, underprepared students were more likely to be male, to be in their first year of university, and to speak English as an additional language. Underprepared students also achieved a lower mean course grade than well-prepared students.

Table 2

Demographics in All Students and Each Subsample

	All students (n = 189)		Underprepared students (n = 27)		Well-prepared students (n = 32)	
	n	%	*n*	%	*n*	%
Task 1	147	78	27	100	32	100
Task 2	189	100	25[a]	93	32	100
Sex						
Female	111	59	14	52	24	75
Male	78	41	13	48	8	25
Faculty						
Social Sciences	102	54	14	52	15	47
Humanities / Fine Arts	33	17	5	19	8	25
Business	33	17	6	22	7	22
Science / Engineering	21	11	2	7	2	6
Year						
First	117	62	20	74	18	56
Second	50	26	6	22	9	28
Third or higher	20	11	1	4	5	16
English as a first language						
Yes	126	67	14	52	28	88
No	60	32	13	48	4	12
	M	*SD*	*M*	*SD*	*M*	*SD*
Age	19.6	2.1	19.1	1.5	19.7	2.1
Course grade on a 9-point scale	5.1	2.2	3.7	2.0	6.6	1.5

[a]One underprepared students did not show up for the second task and one was denied entry for not submitting a concept summary sheet.

Collaborative Tasks

Students worked in groups of three to five to complete two CSCL tasks divided into five steps each: (a) Step 1: a 10-min individual planning session (solo planning), (b) Step 2: a 20-min group planning session (group planning), (c) Step 3: an activity designed to help students solidify and coordinate individual expertise, (d) Step 4: a 90-min online collaborative problem-solving session to complete the assignment itself, and (e) Step 5: a 20-min individual guided reflection session (solo reflection).

Each problem-solving task in Step 4 included a written scenario about a struggling student. For Task 1, groups received a one-page scenario of a student preparing for, writing, and submitting a research paper for his history course. The scenario included issues related to five topics covered during the first half of the course: self-regulated learning, task understanding, goal-setting and monitoring, regulating time and procrastination, and regulating motivation. Part A of the assignment contained a list of course concepts within each of those five topics, and groups were asked to specify an example from the scenario of each concept and explain if it was a strength or weakness. In Part B, groups were asked to first identify the root of the student's problem and then explain why that was the main problem using course concepts and specific examples from the scenario.

For Task 2, groups received a one-page scenario of a student preparing for, studying, and writing the final exam for her psychology course. Issues in this scenario were related to five topics covered in the last half of the course: self-regulated learning, memory and attention, learning and processing for meaning, regulating test preparation and test taking, and regulating reading and notetaking. In Part A of the assignment, groups identified and justified (a) the student's five most important problems as well as (b) the root of the problem. In Part B, groups proposed and justified one strategy focused on planning and one strategy focused on reading, notetaking, test preparation, or test taking.

During the week following the in-class collaborative session, students individually completed a solo reflection (Step 5). Figure 1 displays the steps in each assignment, along with points of data collection relevant to this study.

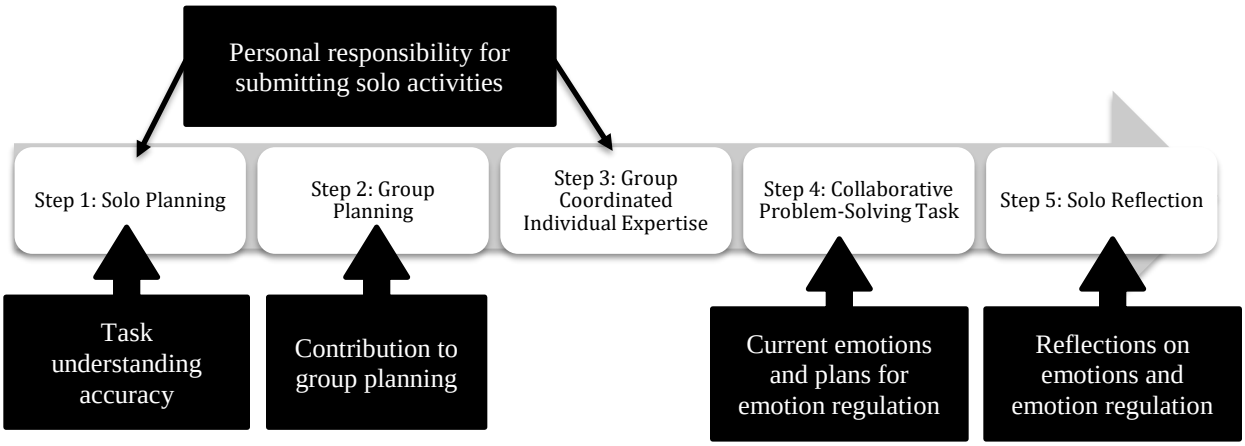

Figure 1. Steps in the collaborative assignment with points of data collection.

Measures

Data about students' planning and preparation for each in-class collaborative problem-solving task (CSCL Tasks 1 and 2) were obtained from the following sources: (a) solo planning tool, (b) solo activity submission logs, and (c) group planning chat logs. Data about students' emotional experiences during CSCL Tasks 1 and 2 were obtained from the Socio-Emotional Sampling (SEST; Webster & Hadwin, 2014) and the Socio-Emotional Reflection Tool (SERT; Webster & Hadwin, 2012). See Figure 1 for points of data collection during each assignment.

Task understanding accuracy. Given the important role of task understanding in planning and regulating (Winne & Hadwin, 1998), we included students' individual understanding of the task as one indicator of preparation. In the first step of the collaborative assignment, students individually completed a solo planning tool in which they figured out *what* the task was asking them to do (explicit features) and *why* they were being asked to do it (implicit features). The tool prompted students to identify 5 correct explicit features from a list of 10 options and 5 correct implicit features from a list of 10 options. For this study, each student

received a score of 0-10 for task understanding. To weight this score equally with personal responsibility (the next measure), each score out of 10 was transformed to a score out of 1.

Personal responsibility for submitting solo activities. To prepare for the task, students were required to complete two solo activities: (a) the solo planning tool and (b) a concept summary sheet on one topic that each group member would bring to the collaborative problem-solving task. Submission logs were examined to determine if students submitted both solo activities by the deadline. As a measure of personal responsibility, students were assigned a score of 0, .5, or 1 depending on the number of activities submitted on time.

Contribution to group planning. In Step 2, groups completed a group planning tool during a separate online session prior to the collaborative problem-solving task. Groups discussed their responses to the group planning tool in a chat and recorded their responses in a shared wiki. Only one member of the group could edit the wiki at a time, but all members could view changes once the wiki was saved. Word counts for each student were calculated for the group chat and the group wiki separately. Because not all group members were required to contribute to the wiki, students' relative contributions to group planning were primarily determined by their chat word counts. Students were assigned a score of 1 (substantial contribution) when their chat word counts were at least 1 standard deviation above the mean word count across all students in the course or they contributed more than expected relative to their group members. Although chat word counts were the primary indicator, wiki word counts were taken into account when a student made a substantial contribution that would otherwise go unnoticed. For example, if a group member made the majority of wiki edits in their group and there was little discussion in the chat as a source for those edits, we considered this to be a substantial contribution to group planning by that group member. Students were assigned a score

of 0 (minimal contribution) when they contributed more than 0.5 of a standard deviation below the mean chat word count across all students or they contributed less than expected relative to their group members.

Emotions and plans for emotion regulation during collaboration. Data about students' emotional experiences during collaboration were captured in the Socio-Emotional Sampling Tool (SEST; Webster & Hadwin, 2014). The SEST is a context-sensitive self-report tool developed to assess current emotions and plans for regulating emotions. The tool is formatted with drop-down menus and brief open-ended text boxes embedded in first-person sentences, allowing students to quickly construct a self-narrative about a salient emotion at that moment (see Figure 2). Students completed the SEST at three check-points during the collaborative session: (a) at the beginning of the session (check-in), (b) after completing the first part of the case analysis task (check-up), and (c) at the end of the session (check-out).

The following data from the SEST were examined for this study: (a) ***current salient emotion*** related to working with the group, selected from a drop-down list of six positive (excited, optimistic, confident, happy, focused, calm) and six negative emotions (anxious, worried, stressed, doubtful, frustrated/angry, disappointed); (b) ***evaluation of emotion*** as good or bad, (c) ***intended strategy*** for regulating their emotion, selected from a drop-down list of eight strategies (i.e., creating a good plan, changing the plan or approach, focusing on the task, changing thoughts or beliefs, thinking positively, talking to others in the group, taking deep breaths and/or relaxing, accepting it and carrying on), and (d) perceptions of who should enact the strategy, referred to as ***mode of regulation*** (i.e., "this is something… *I should do, each of us should do, others in my group should do, we should all do together*").

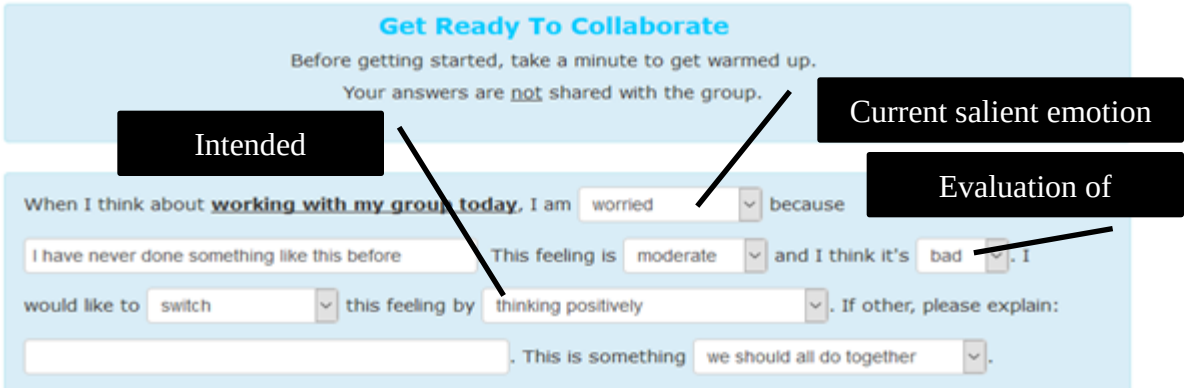

Figure 2. Sample items from the Socio-Emotional Sampling Tool (SEST).

Reflections on emotions and emotion regulation. Students' individual reflections on the collaborative experience were documented in the Socio-Emotional Reflection Tool (SERT; Webster & Hadwin, 2012), completed as part of their solo reflection in Step 5. Similar to the SEST, the SERT is a self-narrative constructor tool containing open text fields and drop-down lists embedded in first-person sentences. The SERT prompts students to reflect on a positive or negative experience by describing their experience in an open text field and then reflect on a salient emotion during that experience as well as their regulation of that emotion (see Figure 3).

The following SERT data were examined for this study: (a) ***valence of experience*** (positive or negative); (b) ***recalled salient emotion***, selected from a drop-down list containing the same emotions as in the SEST; (c) what students did individually when they experienced their emotion, described in an open-text field ***(solo strategy)***; (d) what students perceived their group did when they experienced their emotions, described in an open-text field ***(group strategy)***; (e) ***helpfulness for regulating emotion*** of the solo and group strategies (*helpful* or *not helpful*); (f) ***effectiveness for progress*** of the solo and group strategies ("doing this made it…*a lot easier, a little easier, neither harder nor easier, a little harder, a lot harder*…to complete the task"); and (g) ***mode of regulation*** for the group strategy ("this was something…*we all did together, each of us did, my other group members did, N/A [my group didn't do anything]*").

Solo and group strategy descriptions were coded for a previous study (see Webster & Hadwin, 2019 for details). Table 3 contains the coding scheme. All codes could be applied to both solo and group strategy descriptions, with the exception of positive thinking / changing thought, which was applied only to solo strategy descriptions.

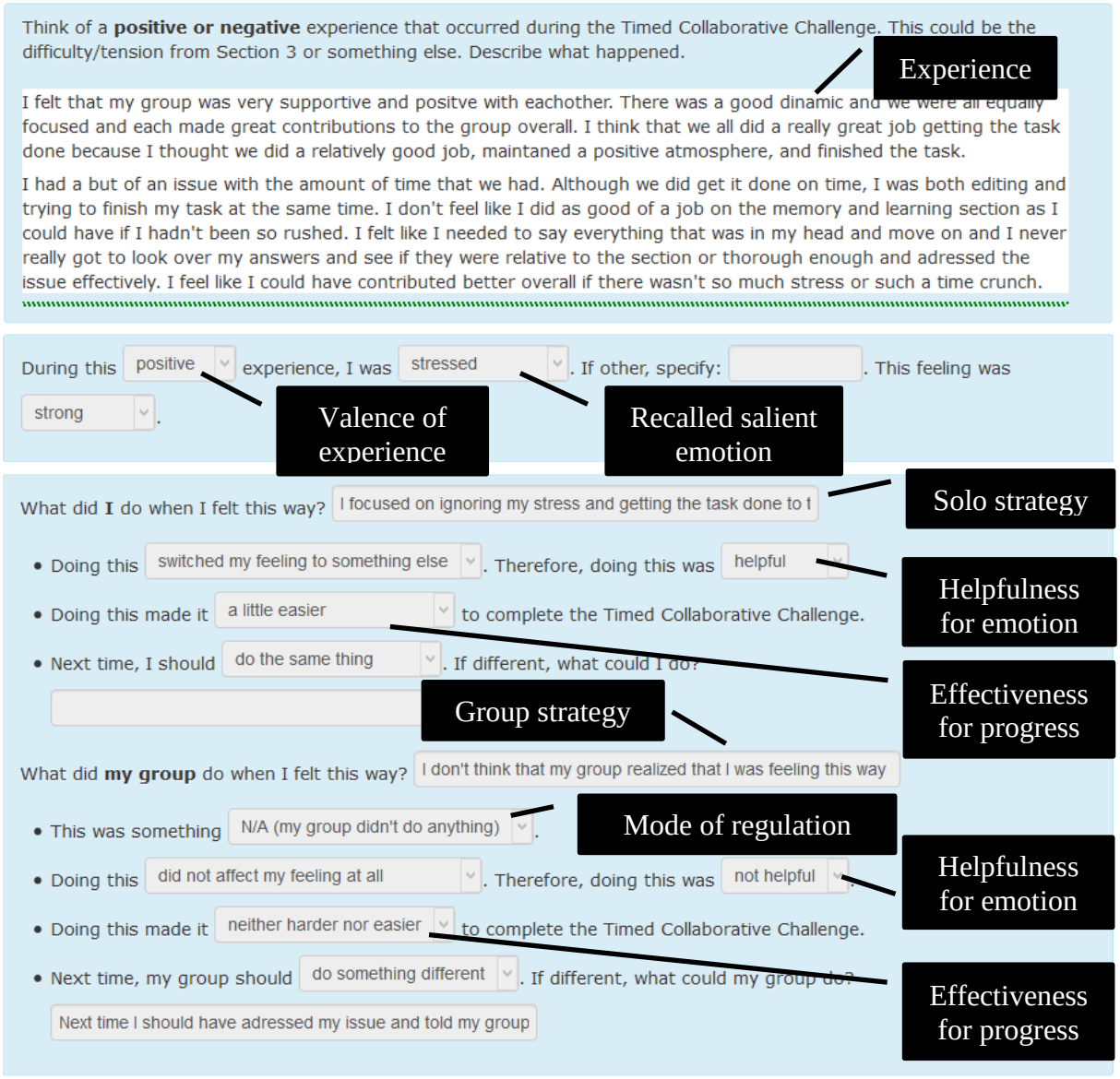

Figure 3. Items from the SERT.

Table 3

Codes and Descriptions of Solo and Group Strategies

Code	Description
Focusing on the task	Redirecting attention to the task; maintaining or increasing focus on the task or parts of the task; putting more effort into the task; doing one's best; calmly completing the task; offering to do more work.
Socio-emotional support	Actions that are social in nature and contribute to a positive / productive group climate, such as encouraging participation, motivating others, checking in, providing positive feedback, accommodating needs (e.g., slowing down), actively communicating, and explaining an action that may be perceived negatively.
Co-constructing answers	Working together to answer questions by contributing to discussions, building on each other's ideas, and monitoring each other's work. Does not include dividing up the work or answering questions separately.
Regulating plans / approach	Understanding the task; making plans; monitoring progress; making changes to plans or approach.
Relaxing	Taking deep breaths; relaxing; calming down or remaining calm; calmly doing something.
Doing nothing	Doing nothing or continuing the same previously ineffective action (e.g., asking the same question over and over). Also includes instances where students indicated their group was unaware of the event or their feelings.
Positive thinking / changing thoughts	Thinking positively; motivating oneself; changing one's own thinking or beliefs about the task. This code is reserved for internal positive thinking, not positive actions shared among the group (coded as socio-emotional support instead).
Expressing concerns / help-seeking	Expressing or communicating concerns, challenges, and/or negative feelings; asking for help.
Discouraging participation / disengaging	Discouraging participation or undermining task contributions by criticizing another's work, ignoring feedback or questions, or rejecting contributions. Also includes undermining one's own or the group's abilities (low efficacy) and avoiding commitment to the task or reducing engagement.
Compensating	Compensating for another member's low participation or absence from the task; taking over someone's part when they encounter difficulties.
Censoring or suppressing	Not sharing emotions or concerns with the group; ignoring the emotion.

Findings

To determine patterns of emotional processes that may distinguish underprepared from well-prepared students, we examined (a) the emotions students reported experiencing in their SEST responses at the beginning, middle, and end of each task and in their SERT responses after each task; (b) the types of strategies students planned to use for regulating their emotions at the

beginning and middle of each task and recalled actually using after each task; and (c) the evaluations students made about the effectiveness of their recalled strategies.

Patterns of Emotions Within and Across Tasks

SEST Responses: Emotions Reported During Each Task. Contrary to our hypothesis that underprepared students would report more negative emotions than well-prepared students, the opposite pattern emerged (see Table 4). Overall, underprepared students tended to report positive rather than negative emotions throughout the task (at the beginning, middle, and end) with the highest proportion of positive emotions being reported at the end of the task (85%). Findings were consistent for both Tasks 1 and 2. Underprepared students may have been overly optimistic about the task because they lacked awareness of the task criteria or the relevant domain concepts.

For well-prepared students, reports of emotions differed between Tasks 1 and 2. Overall, these students tended to be more negative at the beginning and middle of Task 1 (53% and 69%, respectively), with positive emotions emerging at the end of the task (63%). These well-prepared students tended to be slightly more positive at the beginning of Task 2 (55%), but positive emotions emerged at the middle of the task (62%) and dominated by the end of the task (80%).

Students' evaluations of their emotions as good or bad were also examined. Evaluations were generally consistent with the valence of their emotions; however, the most common discrepancy occurred when well-prepared students evaluated their negative emotions as good. For example, at each stage of Task 1, three well-prepared students (not always the same students) evaluated their negative emotion as good. In contrast, inconsistencies did not occur in Task 1 for underprepared students. This may indicate that well-prepared students hold different perceptions of their emotions (particularly negative emotions) than underprepared students.

Table 4

Number of Underprepared and Well-Prepared Students Reporting a Positive or Negative Emotion During Each Task

	Underprepared				Well-prepared			
	Task 1		Task 2		Task 1		Task 2	
	n	%	*n*	%	*n*	%	*n*	%
Beginning								
Positive	19	73	19	76	15	47	17	55
Negative	7	27	6	24	17	53	14	45
Middle								
Positive	14	56	17	68	9	31	20	62
Negative	11	44	8	32	20	69	12	38
End								
Positive	23	85	21	91	19	63	24	80
Negative	4	15	2	9	11	37	6	20

A limitation of group-based frequency summaries is they are not sensitive to within-person variations in emotions over time. Therefore, to capture within-person patterns in each task, conditional probabilities of emotions were examined by computing the percentage of students reporting a positive or negative emotion given their previously reported emotion (see Table 5). For example, in Task 1, 73% of underprepared students reported a positive emotion at the beginning of the task. The majority of those students (63%) also reported positive emotions midway through the task and continued to report positive emotions at the end of the task (100%). Overall, the dominant probability pattern for underprepared students was to report positive emotions throughout the different stages of Tasks 1 and 2 (Tables 5 and 6). Although positive emotions may seem like a good thing on the surface, they may also point to a lack of task, team, or domain awareness. That is, things may feel fine when students lack knowledge and awareness of relevant task, team, and domain competencies.

In contrast, for Task 1, students who were well-prepared tended to report negative emotions with positive emotions only emerging at the end of the task. By Task 2, 53% of well-

prepared students reported positive emotions when they started the task. Students who continued feeling positive midway through the task (53%) were also likely to report feeling positive at the end of the task (78%).

Table 5

Conditional Probabilities for Task 1

	Beginning			Middle			End		
	Valence	*n*	%	Valence	*n*	%	Valence	*n*	%
Underprepared	P	19	73	P	12	63	P	12	100
							N	0	0
				N	7	37	P	6	86
							N	1	14
	N	7	27	P	1	14	P	1	100
							N	0	0
				N	4	57	P	2	50
							N	2	50
Well-prepared	P	15	47	P	5	33	P	5	100
							N	0	0
				N	9	60	P	6	67
							N	3	33
	N	17	53	P	4	24	P	2	50
							N	2	50
				N	11	65	P	5	45
							N	5	45

Note. Total numbers of students in each group vary across check-ins due to missing data. P = positive; N = negative.

Table 6

Conditional Probabilities for Task 2

	Beginning			Middle			End		
	Valence	*n*	%	Valence	*n*	%	Valence	*n*	%
Underprepared	P	19	76	P	14	74	P	13	93
							N	0	0
				N	5	26	P	3	60
							N	2	40
	N	6	24	P	3	50	P	3	100
							N	0	0
				N	3	50	P	2	67
							N	0	0
Well-prepared	P	17	53	P	9	53	P	7	78
							N	0	0
				N	8	47	P	6	75
							N	2	25
	N	14	44	P	11	79	P	9	82
							N	2	18
				N	3	21	P	1	33
							N	2	67

Note. Total numbers of students in each group vary across check-ins due to missing data. P = positive; N = negative.

SERT Responses: Salient Experience and Emotion Recalled After Each Task.

Students' reflections on a salient emotional experience revealed similar patterns to their SEST responses. Underprepared students were more likely to recall a positive experience and a positive emotion in Task 1, whereas well-prepared students were more likely to recall a negative experience and negative emotion. In Task 2, both types of students were more likely to recall a positive experience and a positive emotion (see Table 7).

Table 7

Number of Underprepared and Well-prepared Students Recalling a Positive or Negative Experience and Emotion in Each Task

	Underprepared				Well-prepared			
	Task 1		Task 2		Task 1		Task 2	
	n	%	*n*	%	*n*	%	*n*	%
Experience								
Positive	18	67	14	64	14	44	22	69
Negative	9	33	8	36	18	56	10	31
Emotion								
Positive	19	70	13	59	10	31	19	59
Negative	8	30	9	41	22	69	13	41

Summary. Across both data sources (SEST and SERT), underprepared students were more likely to consistently report positive emotions, whereas more fluctuation occurred in well-prepared students. Changes in the valence of emotions over the stages of Task 1 and between Tasks 1 and 2 may indicate the presence of adaptive emotion regulation for well-prepared students.

Types of Strategies for Regulating Emotions

SEST Responses: Planned Strategies During Each Task. To determine if strategy choices differed between underprepared and well-prepared students, we examined the strategies students proposed for regulating emotions reported at the beginning and middle of each task. Table 8 contains the top strategies proposed by students within and across tasks (see Appendix A for frequencies of all strategies). Task focus was the most frequently identified strategy by both underprepared and well-prepared students across all stages. Creating a good plan was more frequently identified by well-prepared students than underprepared students, particularly at the beginning of Task 1. This suggests well-prepared students may have entered the task with greater awareness of the importance of planning.

Table 8

Top Planned Strategies for Regulating Emotions During Each Task

Check-in	Underprepared		Well-prepared	
Beginning	Task 1 (n = 26)	Task 2 (n = 19)	Task 1 (n = 32)	Task 2 (n = 29)
	Focusing on the task (54%)	Focusing on the task (68%)	Focusing on the task (31%)	Focusing on the task (45%)
	Thinking positively (19%)		Thinking positively (28%)	Creating a good plan (28%)
			Creating a good plan (22%)	
Middle	Task 1 (n = 24)	Task 2 (n = 25)	Task 1 (n = 29)	Task 2 (n = 32)
	Focusing on the task (42%)	Focusing on the task (52%)	Focusing on the task (52%)	Focusing on the task (50%)
	Thinking positively (21%)	Thinking positively (20%)	Thinking positively (24%)	Thinking positively (25%)

Note. Strategies planned by five or more students are listed.

In terms of who should take responsibility for regulating their emotion reported at each stage of the collaboration, students most frequently reported that regulation should be done together (see Table 9). This was true for both well-prepared and underprepared students across both tasks, with the exception of underprepared students at the midpoint of Task 1 when they most frequently indicated each group member should enact the strategy (36%). Overall, this finding indicates that during teamwork, students perceive emotions as a shared responsibility rather than something that should be regulated independently—and this appears to be the case regardless of how prepared students are entering the task

However, a greater proportion of well-prepared students than underprepared students planned to self-regulate their emotions, particularly at the midpoint of Task 2 (33% vs. 17%), suggesting well-prepared students not only take more personal responsibility for planning before

the task but may also take more personal responsibility for regulating their emotions during the task.

Table 9

Number of Underprepared and Well-Prepared Students Planning to Use Each Mode of Regulation During Each Task

	Underprepared				Well-prepared			
	Task 1		Task 2		Task 1		Task 2	
Mode	*n*	%	*n*	%	*n*	%	*n*	%
Beginning								
We should all do together	13	59	13	59	17	57	15	52
Each of us should do	5	23	4	18	7	23	6	21
I should do	4	18	4	18	6	20	7	24
Others in my group should do	0	0	1	5	0	0	1	3
Middle								
We should all do together	7	32	12	52	10	40	12	44
I should do	6	27	4	17	8	32	9	33
Each of us should do	8	36	4	17	7	28	5	19
Others in my group should do	1	5	3	13	0	0	1	4

Note. Modes listed in descending order across students and tasks.

SERT Responses: Recalled Strategies After Each Task. To determine if the use of strategies differed between underprepared and well-prepared students, we examined the solo and group strategies students described using to regulate a salient emotion during each task. Table 10 contains the top solo and group strategies reported by students after each task (see Appendix B for frequencies of all strategies). Similar to their SEST responses, both underprepared and well-prepared students were more likely to describe individually focusing on the task in response to their salient emotion. Well-prepared students were also slightly more likely to report helping their group to co-construct answers.

In Task 1, the top group strategies for both underprepared and well-prepared students included socio-emotional support and focusing on the task, but underprepared students also most frequently reported co-constructing answers. In Task 2, underprepared students were most likely

to report focusing on the task as their top strategy, whereas well-prepared students were most likely to report socio-emotional support as their top strategy. The majority of students indicated their group shared in the regulation of their strategies (Table 11). However, across tasks, the proportion of well-prepared students reporting shared regulation increased from 50% to 86%, whereas it stayed at just over half for underprepared students.

Summary. Overall, there was little variation in the types of strategies students planned to use in the SEST and recalled using in the SERT. Students generally reported a limited number of strategies, such as focusing on the task, most frequently. In addition, students most frequently identified shared enactment of strategies in both their plans for regulating and their retrospective reports of regulating. However, well-prepared students were more likely than underprepared students to (a) identify creating a good plan at the beginning of the task, (b) plan to self-regulate their emotions, (c) report socio-emotional support as a group strategy in Task 2, and (d) report shared regulation of group strategies in Task 2. Underprepared students were more likely than well-prepared students to describe co-constructing answers as a group strategy, particularly in the first task. Thus, although strategies were often similar across students, there may be some subtle differences in how underprepared and well-prepared students regulate their emotions.

Table 10

Top Recalled Solo and Group Strategies for Regulating Emotions During Each Task

Strategy	Underprepared		Well-prepared	
	Task 1 (n = 26)	Task 2 (n = 22)	Task 1 (n = 32)	Task 2 (n = 32)
Solo	Focusing on the task (50%)	Focusing on the task (55%)	Focusing on the task (50%)	Focusing on the task (38%)
			Co-constructing answers (19%)	Co-constructing answers (16%)
			Relaxing (19%)	
Group	Co-constructing answers (38%)	Focusing on the task (45%)	Focusing on the task (34%)	Socio-emotional support (50%)
	Socio-emotional support (35%)	Socio-emotional support (23%)	Socio-emotional support (31%)	Focusing on the task (28%)
	Focusing on the task (31%)	Co-constructing answers (23%)		Co-constructing answers (22%)

Note. Strategies reported by five or more students are listed.

Table 11

Mode of Regulation of Group Strategies

	Underprepared				Well-prepared			
	Task 1		Task 2		Task 1		Task 2	
Mode	*n*	%	*n*	%	*n*	%	*n*	%
We all did together	12	52	10	53	14	50	25	86
My other group members did	7	30	5	26	11	39	3	10
Each of us did	4	17	4	21	3	11	1	3

Note. Modes listed in descending order across students and tasks.

Evaluations of Strategy Effectiveness

In our final analysis, we examined students' perceptions of the effectiveness of the solo and group strategies they described in their SERT responses completed after each task. Students' evaluated the effectiveness of their strategies using two metrics: (a) whether the strategy was *helpful* or *not helpful* for achieving regulation goals and (b) how much the strategy facilitated

progress on the task. In terms of helpfulness for achieving regulation goals, both underprepared and well-prepared students favorably evaluated both solo and group strategies (Table 12). However, whereas the proportion of students rating their group strategy as helpful decreased slightly for underprepared students over time, it increased for well-prepared students.

Students rated effectiveness for facilitating task progress on a 5-item scale from *a lot harder* (scored as -2) to *a lot easier* (scored as 2). Mean ratings of effectiveness indicated well-prepared students were less positive than underprepared students about their group strategies in Task 1, but more positive than underprepared students in Task 2 (Table 13). Similarly, well-prepared students perceived their solo strategies to be more effective in Task 2 compared to underprepared students.

Table 12

Number of Underprepared and Well-Prepared Students Evaluating Their Strategies as Helpful or Not Helpful for Regulating Emotions

	Underprepared				Well-prepared			
	Task 1		Task 2		Task 1		Task 2	
	n	%	*n*	%	*n*	%	*n*	%
Solo								
Helpful	25	93	19	86	30	94	29	91
Not helpful	2	7	3	14	2	6	3	9
Group								
Helpful	22	81	17	77	24	77	29	91
Not helpful	5	19	5	23	7	23	3	9

Table 13

Mean (SD) Effectiveness of Strategies for Facilitating Progress

	Underprepared				Well-prepared			
	Task 1		Task 2		Task 1		Task 2	
	n	*M (SD)*	*n*	*M (SD)*	*n*	*M (SD)*	*n*	*M (SD)*
Solo	27	0.89 (0.97)	22	0.86 (1.28)	32	0.84 (0.85)	32	1.13 (1.01)
Group	26	1.23 (0.86)	22	1.14 (1.08)	31	0.84 (1.32)	32	1.28 (0.89)

Note. Scores could range from -2 (*a lot harder*) to 2 *(a lot easier*).

Summary. Evaluations of strategy effectiveness indicate underprepared and well-prepared students are generally positive about the solo and group strategies they described using. However, similar to emotions reported within and across, well-prepared students demonstrated a positive shift across tasks, particularly with respect to the group strategies they reported. This provides another piece of evidence that well-prepared students may be adaptively regulating over time.

Discussion

The purpose of this study was to examine the link between individual preparation and patterns of emotion regulation during two CSCL tasks. Findings revealed differences in the dominant patterns of underprepared and well-prepared students both within and across tasks. Despite overall similar plans and reports of emotion regulation strategies, underprepared students demonstrated relatively stable patterns of positive emotions and positive evaluations of their strategies, whereas well-prepared students demonstrated more fluctuation within tasks and a shift towards more positive emotions and evaluations across tasks.

In addition, although the differences between underprepared and well-prepared students were most apparent in their emotions and evaluations, there were some key differences in terms of emotion regulation strategies and modes of regulation. For example, well-prepared students were more likely to propose creating a good plan at the beginning of the task and were more

likely to plan on individually regulating their emotions. From one task to the next, the frequency of well-prepared students reporting shared enactment of the group strategy increased, but stayed the same for underprepared students. Finally, after the first task, underprepared students were more likely to recall co-constructing answers as a group strategy.

Individual Differences in Conditions for Emotional Experiences and Regulation During Collaboration

These findings point to the importance of taking into account individual differences in (meta)cognitive, motivational, and emotional factors when examining regulation during collaboration (Järvenoja et al., 2018). Emotions can be viewed as products of multiple factors, including appraisals, attributions, goals, social context, past socio-historical experiences, and genetic dispositions, among others (Järvenoja et al., 2018; Pekrun, 2016). From the perspective of Winne and Hadwin's (1998, 2008) model, these factors can be viewed as conditions that set the stage for engagement in regulation. That is, within and across each phase of collaboration—from planning before the task through enacting the task to reflecting after the task—there are multiple variables influencing how students engage in those phases at both an individual and group level (Hadwin et al., 2018). Thus, the underprepared and well-prepared students in this study may be characterized by a set of diverse conditions that differentiate their emotional experiences and regulation during collaboration. We now turn to a more detailed discussion of some of these potentially differentiating factors.

Different levels of metacognitive awareness. First, inadequate preparation and planning for collaborative work may result in poor metacognitive awareness about how things are going. Calibration research consistently indicates that lower-achieving students tend to be less accurate and overconfident in their predictions of performance, whereas higher-achieving students tend to

be more accurate and underconfident in their predictions (Bol, Hacker, O'Shea, & Allen, 2005; Hacker, Bol, & Keener, 2008). As Pieschl (2009) points out, students with weaker task understanding may have more trouble making accurate predictions of performance. Although participants in our study were not explicitly making predictions of performance, it is plausible their appraisals of current task performance influenced their current emotional state. More specifically, underprepared students had lower task understanding scores, suggesting they were less able to accurately assess current task performance. Inaccurate appraisals of task performance may have led to overconfidence and, subsequently, positive emotions. This may also explain why underprepared students were biased towards recalling positive experiences and positive emotions along with favorable evaluations of emotion regulation strategies in their reflections. At this point, they still did not have external grade feedback and may have continued to hold less accurate task perceptions.

Alternatively, well-prepared students may have held inaccurate perceptions of progress, with a tendency to be underconfident about how things were going. However, mean grades across all groups on each task were not high (Task 1 = 61.8%; Task 2 = 64.1%), indicating the task was challenging for students. It seems more likely, therefore, that the negative emotions of well-prepared students more accurately reflected progress than the positive emotions of underprepared students.

It is also worthwhile to point out that well-prepared students were more likely to evaluate their negative emotions (mainly anxiety) as a good thing, suggesting they realized there may be benefits to these feelings (e.g., motivating them to focus on and put effort towards the task). Indeed, Carver and Scheier's (1990) control-process view of affect indicates that negative affect arises when progress towards goals is inadequate, which can prompt corrective action and further

effort to increase progress. The discrepancy between emotion valence (positive vs. negative) and emotion evaluation (good vs. bad) was only observed in well-prepared students in the first task; perhaps these students felt sufficiently prepared to handle the challenges of the task and therefore viewed their negative emotions as a form of motivation. In contrast, the underprepared students who reported negative emotions may have been less optimistic about completing the task in the face of challenges.

Different goals or standards. Understanding students' goals and standards for collaboration may help explain the different patterns of emotions. For example, underprepared students may direct their regulatory processes towards different goals, such as feeling good (Boekaerts, 2011; Boekaerts & Niemivirta, 2000), or they may have lower standards for the task, allowing for more positive appraisals. In addition, underprepared students may hold different achievement goals. Pekrun, Elliot, and Maier (2006) found that discrete emotions were associated with distinct achievement goals. For example, mastery goals positively predicted enjoyment, hope, and pride, whereas performance-avoidance goals positively predicted anxiety, hopelessness, and shame. Future research should examine underprepared and well-prepared students' goals and standards around the task to determine what role those play in students' emotions and emotion regulation. Underprepared students may have succeeded at maintaining their good feelings, but these emotions may have come at the expense of productively regulating other aspects of the task. The fluctuations observed in well-prepared students within the first task in particular may indicate these students were less successful with regulating their emotions; however, they may have been focused on regulating different aspects of the task. Over time, this may have been a benefit, as indicated by the shift towards more positive emotional experiences in the second task.

Social desirability bias. If positive affective states are viewed as desirable (Larsen, 2000; Westen, 1994), underprepared students may have felt more pressure to report positive emotions. Along the same line, they may have aimed to present their collaborative experience in a positive light, resulting in more favorable responses in their reflections. Social desirability bias refers to the tendency of research participants to respond in a socially desirable way (King & Bruner, 2000; Nederhof, 1985). Although SEST and SERT responses were not available to other group members, underprepared students may have felt the need to present themselves positively to course instructors who had access to their SEST responses and graded their reflections. Social desirability may be a factor to take into account in future research examining self-reports during and after collaboration, especially if group awareness tools are used to display emotion data to the whole group.

Culture or language differences. Finally, it is worthwhile to point out that almost half of the underprepared students self-reported English was *not* their first language, whereas only 4 of 32 well-prepared students reported English as an additional language. Thus, it is possible there were cultural differences at play. For example, people from collectivist cultures may focus more on managing negative emotions and/or they may be less willing to express negative emotions at the risk of disrupting group harmony (Bond, 1993; Markus & Kitayama, 1991; Xu et al., 2014). However, we do not know with which cultures students in our study identified, so it is difficult to further speculate about cultural differences. Regardless, this finding may have implications for practice. Given that students with English as an additional language were over-represented in the underprepared students, this group of students may need different or additional support when planning for groupwork. For example, they may have more difficulty understanding language or expectations provided in assignment descriptions (resulting in lower task understanding

accuracy) and/or they may be less willing to contribute to group chats (resulting in minimal contributions to group planning). Overall, this finding requires further investigation to understand what factors are at play in the underprepared students.

Differences in Emotion Regulation Strategies and Modes of Regulation

Examining students' plans for regulating their salient emotions during the task as well as their reflections after the task revealed some differences between the two types of students. Although plans were fairly similar across both categories of students, well-prepared students were more likely than underprepared students to plan on creating a good plan in the first task, suggesting they understood the importance of planning for tackling the task and positively impacting their emotions. If underprepared students did not put the effort into planning prior to the task, they may have also put less effort into planning during the task. They may have viewed planning as less important or were less motivated to put in the effort and, instead, felt they could rely on their group members to take the lead.

When reflecting on their experiences in the first task, the top group strategy for underprepared students was co-constructing answers, which they described more frequently than well-prepared students. Although solving the problem together rather than dividing the work is an important part of collaboration (Roschelle & Teasley, 1995), this may be indicative of underprepared students relying on their group members to answer the questions because they are less able to contribute. Analyzing the chat conversations and wiki edits in groups would help to confirm or dispel this hypothesis.

Finally, both underprepared and well-prepared students most frequently identified the group strategy as something the group did together; however, the proportion increased for well-prepared students from one assignment to the next, but not for underprepared students. Given

that the top group strategy for well-prepared students in the second task was socio-emotional support, this finding suggests well-prepared students were more engaged with their group. In the first task, well-prepared students may have been more anxious about completing the task and therefore less focused on engaging with their group. With some experience gained from the first task, these students may have felt more comfortable and confident during the second task, allowing them to more frequently engage in positive socio-emotional interactions.

Limitations

This study employed a purposive sampling approach that targeted extreme cases of students who were more or less prepared. This resulted in relatively small sample sizes, which limits the generalizability of the findings. Although a range of undergraduate students with diverse backgrounds opt to take the learning-to-learn course, generalizability may be further limited if these students hold unique characteristics such as a greater need for learning support and/or a higher motivation to improve their learning. Despite these potential limitations, this study highlighted some important differences between underprepared and well-prepared students that can guide further research with different and/or larger samples.

We examined the emotional experiences and processes of students in two collaborative tasks; however, participants were grouped according to their level of preparation for the first task only. Experiences and outcomes of the first task may have impacted the level of preparation for the second task, which may have subsequently impacted students' emotion regulation during that task. Further examination of planning and preparation prior to the second task may provide more insight into the patterns.

Implications

This research contributes to the field by highlighting the importance of planning and metacognitive awareness in emotion regulation during collaboration. Although planning prior to the task did not specifically target emotion regulation, findings from this study demonstrate that examining emotion regulation within an SRL framework allows for a broader perspective that integrates emotion processes with other aspects of regulation. In addition, this research emphasizes the importance of examining regulation over time in order to capture change and adaptation (Hadwin et al., 2018). Our analysis of students' reports within and across collaborative tasks enabled us to see patterns that potentially indicate adaptive regulation, particularly with well-prepared students. Examining the cycle of planning and emotion regulation in subsequent CSCL tasks takes into consideration that students' emotions may affect their planning and students' planning may affect their emotions. Future research should continue to examine these cycles, including the types of tools that may support students to (a) better prepare for collaborative tasks, (b) become more metacognitively aware of how they are doing and what their emotions are, and (c) more effectively regulate their emotions when necessary.

Finally, researchers and instructors designing collaborative tasks should consider that (a) planning may be meaningfully related to emotion regulation and (b) negative emotions during collaboration may not be indicative of poorly prepared students. As research in this area grows, the goal is to develop tools and interventions that support students to effectively regulate in collaborative tasks. It may be that different types of supports are appropriate depending on individual differences, such as their level of metacognitive awareness, the goals and standards they hold, and other conditions that impact subsequent regulation. For example, underprepared students may benefit from supports aimed at improving metacognitive awareness, whereas well-prepared students may be ready for supports designed to help them effectively manage their

emotions. Future research should also examine the impact of prompting students to metacognitively monitor their preparedness for a task earlier on to determine if this impacts their level of preparedness and subsequent emotion regulation for the task.

Conclusion

Given the lack of research on planning and emotion regulation, this study is an important exploratory step towards understanding how these processes relate and towards developing future studies that build on these preliminary findings. Differences between underprepared and well-prepared students point to the importance of considering a variety of (meta)cognitive, motivational, and emotional variables that may differentiate these students in terms of their emotional experiences and regulation. Students who fail to adequately prepare for a task may enter the task at a metacognitive disadvantage that impacts their ability to accurately assess progress. Alternatively, they may be aware of progress, but choose to focus on feeling desirable emotions. If these students hold different goals or lower standards, they may be less concerned about task progress and outcomes. However, their lack of preparation may adversely impact their group, suggesting intervening to support these students to take personal responsibility and be well-prepared for groupwork is an important target for future research and practice. In terms of well-prepared students, they may benefit from support around regulating negative emotions, but this should be done strategically, especially in cases where their negative emotions provide important information and direct subsequent action. As can be seen, there remains a need for more research into the role of planning in emotion regulation during collaboration.

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Appendix A

Number of Underprepared and Well-Prepared Students Planning Each Strategy in Each Task

	Underprepared				Well-prepared			
	Task 1		Task 2		Task 1		Task 2	
Strategy	*n*	%	*n*	%	*n*	%	*n*	%
Beginning								
Focusing on the task	14	54	13	68	10	31	13	45
Creating a good plan	2	8	4	21	7	22	8	28
Thinking positively	5	19	1	5	9	28	4	14
Taking deep breaths / relaxing	1	4	0	0	3	9	1	3
Accepting it and carrying on	2	8	1	5	1	3	1	3
Talking to others in the group	2	8	0	0	1	3	1	3
Changing thoughts / beliefs	0	0	0	0	0	0	1	3
Doing nothing	0	0	0	0	1	3	0	0
Changing the plan / approach	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0
Total	26	100	19	100	32	100	29	100
Middle								
Focusing on the task	10	42	13	52	15	52	16	50
Thinking positively	5	21	5	20	7	24	8	25
Taking deep breaths / relaxing	3	13	1	4	2	7	3	9
Talking to others in the group	1	4	4	16	2	7	3	9
Creating a good plan	0	0	1	4	3	10	0	0
Changing the plan / approach	2	8	0	0	0	0	1	3
Accepting it and carrying on	1	4	1	4	0	0	0	0
Other	1	4	0	0	0	0	1	3
Changing thoughts / beliefs	1	4	0	0	0	0	0	0
Doing nothing	0	0	0	0	0	0	0	0
Total	24	100	25	100	29	100	32	100

Note. Strategies listed in descending order across students and tasks.

Appendix B

Number of Underprepared and Well-Prepared Students Reporting Solo and Group Strategies After Each Task

	Underprepared				Well-prepared			
	Task 1 (n = 26)		Task 2 (n = 22)		Task 1 (n = 32)		Task 2 (n = 32)	
Strategy	*n*	%	*n*	%	*n*	%	*n*	%
Solo								
Task focus	13	50	12	55	16	50	12	38
Co-constructing answers	4	15	3	14	6	19	5	16
Relaxing	3	12	2	9	6	19	3	9
Regulating plans / approach	2	8	3	14	4	13	1	3
Positive thinking / changing thoughts	2	8	1	5	3	9	2	6
Expressing concerns / help-seeking	2	8	2	9	2	6	2	6
Compensating	2	8	0	0	2	6	0	0
Censoring / suppressing	0	0	0	0	2	6	0	0
Discouraging participation / disengaging	0	0	1	5	0	0	0	0
Doing nothing	0	0	0	0	0	0	1	3
Socio-emotional support	0	0	0	0	0	0	0	0
Group								
Socio-emotional support	9	35	5	23	10	31	16	50
Task focus	8	31	10	45	11	34	9	28
Co-constructing answers	10	38	5	23	4	13	7	22
Doing nothing	2	8	3	14	3	9	1	3
Regulating plans / approach	2	8	1	5	4	13	0	0
Compensating	3	12	0	0	0	0	0	0
Discouraging participation / disengaging	0	0	1	5	2	6	0	0
Expressing concerns / help-seeking	0	0	0	0	0	0	2	6
Relaxing	2	8	0	0	0	0	0	0
Censoring / suppressing	0	0	0	0	0	0	0	0

Note. Strategies are listed in descending order across students and tasks.